Use of Epidemiological and Geostatistical Methods to Understand the Epidemic of Homicides in Baltimore, 2005 to 2017

By

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Abstract

Violence is widely recognized as a public health problem. Baltimore, Maryland, a city 45 miles north of Washington, DC, has experienced homicide rates several times higher than those experienced by the United States as a country since at least 1975. Since 2015, Baltimore City has experienced an epidemic of homicides, with an average homicide rate of over 50 homicides per 100,000 residents.

We analyzed the individual social characteristics of the victims of homicide in Baltimore City between 2005 and 2017. We used descriptive epidemiology to understand the distribution of social risk factors for victimization in individuals. We also used information on the location of homicides in this time period — along with socioeconomic information on Community Statistical Areas (CSA) — to understand the association between neighborhood environmental characteristics and the homicide rates in those CSAs. We finally took inventory of violence prevention programs existing in Baltimore City as of 2017, and we compared the goals of those programs with the findings from the analysis of victims and the victim location.

Through the use of epidemiological and geostatistical methods, we found that not all segments of the population of Baltimore City experienced the same levels of homicide victimization. African American men between the ages of 15 and 34 made up over 61% of the homicide victims between 2005 and 2017 in Baltimore City. Most of the homicides showed spatial clustering around CSAs with elevated levels of poverty and disorder (e.g. broken street lights). Hot spot analysis using person, place, and time showed that hot spots tended to appear or disappear depending on the year of the homicides.

The government and civil society in Baltimore City are working in different ways to address violence. Existing programs would do well to expand into the emerging hot spots of homicides, while other programs would probably have a greater impact on violence if they combined efforts and focused on a specific segment of the population. Finally, there is a great opportunity for healthcare providers to treat violence with the same approaches as other public health problems.

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Chapter 1: Review of Available Evidence and Conceptual Framework

Review of the Literature

A literature review was conducted in order to find the most recent and most pertinent literature and evidence on the association between individual social characteristics, neighborhood environment and the risk of homicide victimization. A search was conducted with emphasis on finding literature pertaining to Baltimore City or addressing the characteristics that may lead to increased numbers of homicides in Baltimore City. We begin this chapter with a discussion of the literature related to characteristics of an individual and their association with homicide perpetration or victimization. We then continue with evidence of an association between the neighborhood or environmental factors and increased risk of homicide perpetration or victimization. This chapter is concluded with a review of the literature on geographic analysis of crime data and its impacts on crime intervention.

Individual Characteristics and Their Association with Violence and Homicide Victimization Risk

The circumstances through which a person becomes a victim of homicide vary depending on their age, gender, and race/ethnicity. In the United States, infants are more likely to be killed by of their own parents or a caregiver (Douglas & Vanderminden, 2014). However, there are differences in the homicide rates of infants between rural and urban counties in the United States, with rural counties having higher rates of infant homicide (Ely & Hoyert, 2013). These homicides are usually the result of impulsive actions not the result of intentionally criminal

activity (Fujiwara, Barber, Schaechter, & Hemenway, 2009). Nevertheless, children between the ages of 5 and 14 had the lowest homicide rate by age group among US residents between 2005 and 2016. The homicide rate then increases starting with the 15-19 age group and peaks with the 20-24 and 25-29 age groups before decreasing starting with the 30-34 age group through the older age groups (Centers for Disease Control and Prevention, 2005). Across age groups, homicide rates in the United States have been higher in males than in females.

When it comes to homicide, men are at higher risk than women, and they are also the most likely to be perpetrators of homicide. Yet, Fox and Fridel (Fox & Fridel, 2017) found that there were significant differences in the proportion of homicides by gender depending on the circumstances of the homicide. For example, if the homicide was the result of intimate partner violence, the victims was more likely to be female. In that same analysis, it was found that women were less likely to be killed by firearm than men. In fact, the Centers for Disease Control and Prevention (CDC) found that more than half of homicides of women were the result of intimate partner violence, and that non-Hispanic black women were at highest risk of being killed by an intimate partner (Petrosky et al., 2017). But that is not where the differences in homicide with regards to race and ethnicity end.

According to the most recent analysis by the Violence Policy Center, African Americans have consistently had an elevated homicide rate per capita compared to other races. Within that group, males have had elevated homicide rates. In 2014, Missouri had the highest homicide rate in African Americans with 34.98 homicides per 100,000 residents. Maryland was ranked 27th with a rate of 14.04 homicides in African Americans per 100,000 residents (Violence Policy Center, 2018).

Lochner and Moretti (Lochner & Moretti, 2004) found that education has the effect of reducing an individual's probability of being arrested and/or imprisoned, and that the effect had more to do with a change in the individuals' criminal behavior than any other influence education may have had on them. Furthermore, they found in their analysis that the differences in educational attainment between African American men and white men explained the difference in their incarceration rates. Homicides at schools, or associated with them, have not passed 48 for the entire country in any given year since the 1992-1993 school year, according to the Department of Education (Musu-Gillette et al., 2018).

Pridemore and Shkolnikov (William A Pridemore & Shkolnikov, 2004) found that education and marriage appeared to be protective factors against homicide victimization in their analysis of data from Moscow, Russia. They concluded that being married and/or educated above the norm for the population provide stability and "social capital." At the same time, being in an intimate relationship alone appears not protective for women. The nature of the relationship places them at higher or lower risk of homicide victimization. As Shackelford found, women who are killed by an intimate partner were more likely to be in cohabiting relationships, compared to married women also killed by an intimate partner. Cohabitating female victims also were more likely to be older in age (Shackelford, 2001).

Hohl (Hohl et al., 2017) found that increased availability of illicit drugs and alcohol at the neighborhood level, and their use at the individual level, led to increased odds of firearm homicide of 13 to 20 year-olds in Philadelphia. In a population-based case-control study from Sweden, Hedlund (Hedlund, Forsman, Sturup, & Masterman, 2018) found that alcohol levels in homicide victims were significantly higher in female victims than males. They also found that alcohol levels in homicide offenders were higher compared to controls. A study of meta analyses

on the association between alcohol, drug use and violence found that, even after controlling for factors like mental illness, substance use/abuse increases the risk of both violence perpetration and victimization. With respect to alcohol, the authors found the risk to be "bidirectional," meaning that the use/abuse of alcohol increased the risk of violence perpetration and victimization "almost identical(ly)" (Duke, Smith, Oberleitner, Westphal, & McKee, 2017).

Employment status has been associated with the risk of homicide, even when adjusting for race. In their analysis, Kposowa and Johnson (Kposowa & Johnson, 2016) found that the national homicide rate has remained low in recent years, even with the economic decline of the Great Recession and the ensuing recovery. When it comes to the association between income inequality and violence, Burraston et al (Burraston, McCutcheon, & Watts, 2018) found that the level of disadvantage at the county level functions as a moderating factor. That is, high income inequality is associated with high crime, or vice-versa, but that association differs based on the level of disadvantage.

In addition to physical distance from a potential victim to a perpetrator of violence, social distance between these two, as well as between a victim and another victim, seems to be a determinant of the risk of violent victimization. A systematic review of 16 studies, published in 2016, found that there is good evidence that someone who is exposed to violence has a higher risk of becoming a victim of violence or becoming perpetrating violence against others. These social networks included family and relatives, household members, and peers outside the home setting (Tracy, Braga, & Papachristos, 2016). In another study, Papachristos and Wildeman (Papachristos & Wildeman, 2014) found that social network distance from a homicide victim was predictive of the risk of victimization in a social network of African Americans within a community. When it came to violent victimization in general, victims and perpetrators may share

similar environments with similar levels of social disorder, and also share or participate in similar risky behaviors (Daday, Broidy, Crandall, & Sklar, 2005).

When it comes to the risk of violence victimization of African American men, Richardson (Richardson, St. Vil, Sharpe, Wagner, & Cooper, 2016) found that being victimized repeatedly was associated with characteristics like being under the influence, criminal history, housing instability, and perceived "disrespect."[1] This cross-sectional study points to the interplay between social individual characteristics and the culture or environment of the neighborhoods where the victims reside or frequent.

Neighborhood/Environment Characteristics and Their Association with Violence and Homicide Victimization Risk

The findings described above with respect to individual characteristics show that there is some form of relationship between the individual and their environment. For example, the risk of violence in African Americans is both associated with their race and ethnicity and how institutions and society relate to them. The risk of intimate partner violence is associated with female gender, but it is exacerbated by social pressures on the intimate relationship. That is, individual and environment characteristics are entangled in such a way that one should not analyze the effect of one on victimization risk without taking into effect the effect(s) of the other. In this section, we pay closer attention to the neighborhood and/or environmental characteristics and their association with violence and homicide victimization.

Several types of places have been associated with violent victimization. For example, alcohol outlets are associated with crime and neighborhood disorder both because of the effects

[1] Disrespect, in this context, is any violation to the "code of the street."

of intoxication on risky behavior and because of the increased availability of potential targets (Roman, Reid, Bhati, & Tereshchenko, 2009). Although, the characteristics of a neighborhood cannot be ignored when looking at these "attractors" of crime. Blair found that opportunity drives crime at those locations more so than the types of locations (Blair, Wilcox, & Eck, 2017). That is, an alcohol outlet or pawn shop or convenience store is more closely associated with crime if it is located in a place where it is opportune for crime to occur, such as a crowded, disorganized or disadvantaged area. Of if there are more motivated offenders along with less guardians.

In a review of literature, Pridemore (William Alex Pridemore, 2002) found that economic strain, social disorganization, and the culture surrounding victims are all associated with homicide. These factors, in turn, arise from factors such as historical segregation, discrimination, and marginalization of racial and ethnic groups, and/or of poor and disadvantaged groups. Bonomi et al (Bonomi, Trabert, Anderson, Kernic, & Holt, 2014) found that intimate partner violence was associated with income at a neighborhood level, though only for the first instance of violence. Subsequent instances were better explained by other factors.

The demographic makeup of a neighborhood is associated with homicide when it comes to immigrants. Akins and Stansfield (Akins & Stansfield, 2009)found that homicide counts declined across time with increased proportion of immigrants per census tract in Austin, Texas. Their findings also showed that it is economic disadvantage that has a significant positive relationship with homicide.

With regards to weather, Michel et al (Michel et al., 2016)found that increased daily temperatures were associated with increased total crime and violent crime, but not with increased

homicides. Precipitation of any kind (e.g. rain or snow) was associated with lowered incidence of crime of all kinds. In their discussion, the authors opine that homicide "is more likely to be premeditated than other crime," and that weather conditions allowing for more interactions between potential victims and victimizers are the driving force between the observed association between increased crime and favorable weather conditions.

Geographic Analysis of Incidence of Victimization

The use of geographic information systems to understand the relationship between public health threats and location is becoming more routine (Fradelos et al., 2014; Musa et al., 2013). Many of the indicators being analyzed in this study as predictors of homicide may show a spatial relationship that may otherwise be missed if the data are not analyzed geographically. For example, it would be a significant finding if homicides were not concentrated in neighborhoods whose environments were similar, or whose environments fostered violent crime. It would also be a significant finding if neighborhoods with elevated homicide rates were not close to each other in space.

Researchers are using geographic information systems (GIS) in order to understand violence. For example, data on intimate partner violence in Valencia, Spain, was analyzed along with data on neighborhood-level social indicators through a geographic information system to understand the influence on risk of violence that those social indicators could have (Gracia, López-Quílez, Marco, Lladosa, & Lila, 2015). Rothman (Rothman et al., 2011) also analyzed the relationship between neighborhood characteristics and intimate partner violence in Boston, Massachusetts. They found that several neighborhood characteristics were associated with perpetration of dating violence, and that the perception of neighborhood disorder varied between youths and adults.

Summary of Findings of the Available Literature

If there is a common theme in so many of these individual and environmental characteristics as predictors of violence, it is economic opportunity and poverty. One study we reviewed linked alcohol outlets and crime (Roman et al., 2009), but those findings were then clarified by the socioeconomic constitution of the places where those outlets were located. In another reviewed study, African American men in urban areas were found to be most at risk for violent victimization and homicide. When controlling for socio-economics, the race and ethnicity were not so much a predictor of victimization as they were the opportunities to gain wealth or meet physical needs available to those men in their neighborhoods that better explained their risk of victimization.

In essence, it is not only the question of *Who?* but also of *Where?* or even *When?* that one must take into account if one is to understand the observed patterns of homicide in Baltimore City. It would be very simple to make broad statements about a particular group or subgroup of people without looking at the entire picture of what leads to victimization. Geographic analysis aids with answering the *Where?* question. Epidemiological analysis informs the *Who?* and *When?* questions. And the vast knowledge gained through criminology informs the *Why?* With that in mind, we will now look at four existing theories of victimization and how they might take into account the interaction of the individual and their environment when it comes to victimization.

Theories of Victimization

There are many theories regarding victimization that are studied by criminologists and others. We will focus on four of these theories (Meier & Miethe, 1993). The first theory, *Victim*

Precipitation Theory, states that a victim may be the one who initiated the violent confrontation that led to their own demise. For example, a person picks a fight with an adversary and pulls out a gun. The adversary then takes the gun and uses it against the person. Whether or not the homicide is defined as justified does not take away from the fact that the event resulted in a death. As can be expected, this theory is controversial in that it places some of the responsibility for the homicide on the victim (Timmer & Norman, 1984).

The second theory, *Deviant Places Theory*, looks at the ecology of where victimization takes place to give context to the event.[2] In this theory, if a neighborhood is in disorder of some sort (e.g. social disorder), then crime is more likely to happen (Stark, 1987). The chain of events that lead to increased crime and victimization in a neighborhood may vary from one place to another. For example, a neighborhood under great stress from a natural disaster may have less crime because the residents band together against a common threat. Then again, the destruction brought on by a natural disaster may lead to increased looting and other illegal acts as public safety resources are pressed into rescue operations. In essence, it is more about the neighborhood's attributes than the neighborhood occupants when it comes to crime and victimization.

A third theory, one that is closely associated with *Deviant Places Theory*, is the *Routine Activities Theory*. This theory looks at three factors in an environment and related to the activities of persons in that environment. First, it looks at the presence of possible targets for victimization. Second, it looks at the existence of "guardians" to prevent crime, like law enforcement, community leaders, or other persons who would enforce a code of conduct and/or

[2] By "deviant," it is meant that the place/neighborhood deviates from the norm.

protect victims from would-be aggressors. Third, it looks at the presence of "motivated offenders," those who would commit a crime (Henson, Wilcox, Reyns, & Cullen, 2010). The balance between these three factors within a human environment is what explains victimization levels within that environment (Ecology, 2017). For example, lack of police presence allows offenders to come into contact with targets. Likewise, there may be guardians to stop crime, but the targets and the offenders are in close proximity to each other, as may be the case in intimate partner violence. Or there may be plenty of offenders and no law enforcement, but a total lack of suitable targets or the opportunity to victimize them.

The fourth theory being considered in this dissertation is the *Lifestyle-Exposure Theory*. This theory shares some characteristics with the *Victim Precipitation Theory* in that the victims' actions (lifestyles) may contribute to their victimization (Meier & Miethe, 1993). For example, a person may live a lifestyle that includes excessive drug and alcohol use, frequenting dangerous parts of town, and befriending those prone to commit crime. Thus, the person is at higher-than-normal risk of victimization. There may also be those people who, by the nature of their identity, participate in lifestyles that also place them at higher risk of victimization. For example, a gay or lesbian person may be targeted for victimization as a result of their sexual orientation. Or an undocumented immigrant may become a target because of their national origin or ethnicity. In all cases, it was the lifestyle of the victims that placed them at higher risk, taking into account other factors such as neighborhood environment or presence/absence of law enforcement.

This dissertation aims to fit those theories within a socio-epidemiological framework of how a person in Baltimore City becomes a homicide victim. Under the theoretical framework developed for this dissertation, the *Lifestyle-Exposure Theory* would come into play when looking at homicide victims' lifestyle, such as their gender, race, and even age group. The

Deviant Places Theory would apply when looking at the neighborhood characteristics of where the homicides took place. The *Routine Activities Theory* would be used to understand the interplay between individuals and their environment as well as the police involvement or other indicators of criminal activity in a neighborhood.

Specific Aims and Hypotheses

Aim #1: To understand the individual characteristics of homicide victims in Baltimore City and how these characteristics explain the variance in homicide counts in Baltimore City.

Hypothesis 1: The variance in homicide counts is explained by victims' personal characteristics, such as their age, gender, and ethnicity.

Aim #2: To understand the environmental characteristics of homicides in Baltimore City and how these characteristics explain the variance in homicide counts across Community Statistical Areas in Baltimore City.

Hypothesis 2: The variance in homicide counts by Community Statistical Area is explained by the neighborhood characteristics of where the homicides occur, such as neighborhood poverty, urban blight, and access to city services.

Aim #3: To identify opportunities for the prevention of victimization by taking inventory of existing violence and victimization prevention programs in Baltimore City.

Hypothesis 3: Existing violence and victimization prevention programs in Baltimore City do not address the factors necessary for successful intervention and prevention of homicides by firearm.

Conceptual Framework

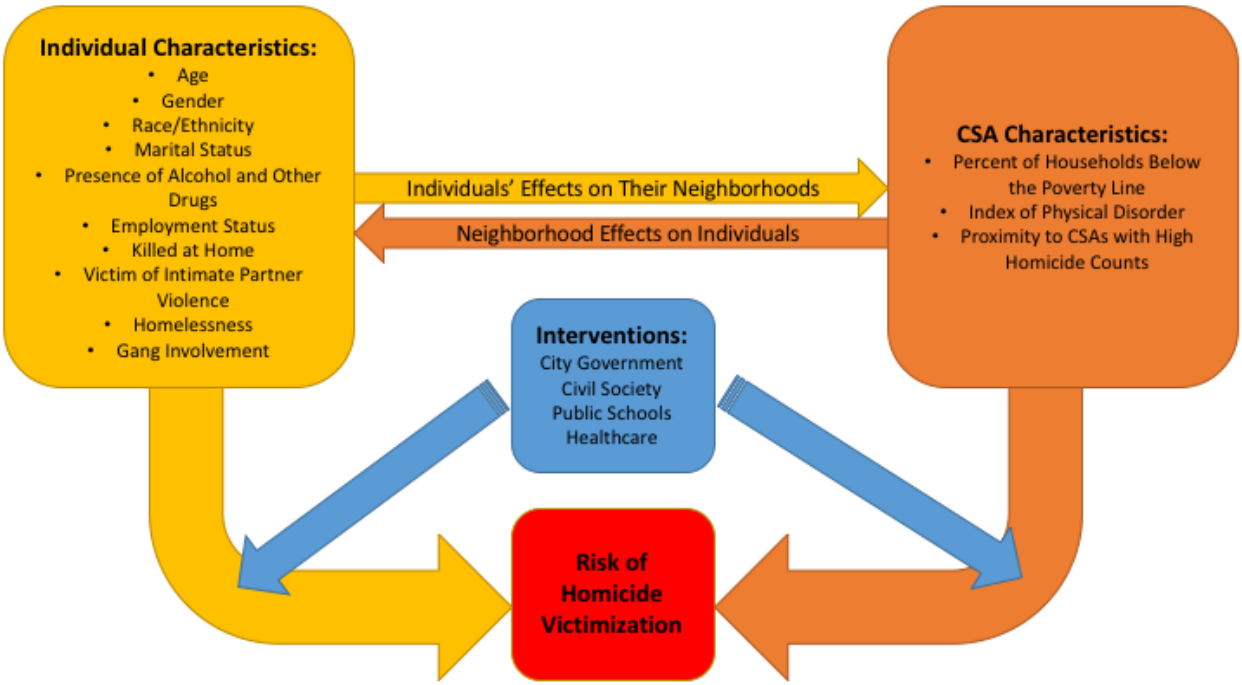

Figure 1.1 – Conceptual framework displaying the relationship between individual social characteristics (Aim #1), Community Statistical Area characteristics (Aim #2), their contribution to homicide victimization, and the points of intervention where programs are aimed (Aim #3) and could reduce the risk of homicide victimization.

Public Health Significance

Violence has been widely recognized as a public health problem. Homicide is the most severe and irreversible outcome of violence. The transition from infectious diseases to chronic diseases and injuries as causes of death, the increase in violence as a significant cause of death in minorities during the 1990s, and the recognition of intimate partner violence as a significant burden on society, all led to the focusing of public health efforts to understand and counteract violence (Dahlberg & Mercy, 2009). The World Health Organization (WHO) asserts that violence is preventable, as it is not a necessary function of being human (World Health Organization, 2002). In more recent years, efforts such as *Cure Violence* in Chicago and *Safe Streets* in Baltimore City, have used primary prevention strategies similar to those used in

preventing chronic or even infectious disease in order to prevent violence ("Violence as a Health Issue," 2018).

Dr. Gary Slutkin of the University of Illinois at Chicago pointed out that violence exhibits traits similar to those seen in epidemic disease (Medicine & Council, 2013, pp. 32-45). He asserts that violence shows "clustering, spread, and transmission," just like an infectious disease. As a result, violence is quantifiable and can be described or explained through different methods. For example, clustering of violence can be described and analyzed through the use of maps and mapping technology. The spread of violence can be described and analyzed through the use of epidemic curves or graphs showing incidence. Finally, the transmission of violence from person to person within social networks can also be studied and understood through different methods that are similar to those used for infectious diseases (Green, Horel, & Papachristos, 2017).

This dissertation aims at helping to understand violent homicide in Baltimore City through observing the characteristics of the victims and the environment in which the homicides occurred. Victim information for this study was collected from two unique sources. One source, the tally of homicides kept by crime reporters at *The Baltimore Sun*, allowed for location-specific information about the homicides to be ascertained. It also allowed for the victims to be identified by name, and some of their personal characteristics were recorded as well. The other source, from the *Maryland Violent Death Reporting System*, allowed for more detailed information about each victim, albeit at the cost of location information.

Through the analysis of the data contained in these two systems, it is hoped that this dissertation shows that additional information not collected by public health (or other official

agencies) can be complemented by information collected by civil society or by media sources. In places where information about a particular health condition or health situation is hard to come by, the techniques used for collecting and completing information for this dissertation may be of use. Similarly, information collected by one group can be compared to the information collected by another and, thus, validated.

Finally, Baltimore is a city that has been plagued with elevated rates of violence, especially homicide. In our review of the literature, few studies have been done in Baltimore City to understand the observed patterns of homicide. Most of our findings centered on news articles and opinion pieces by policymakers and academics, or on research on interventions that were very localized and had a specific demographic target. Essentially, there was no good epidemiological analysis of homicides beyond summary reports that were limited to one year and delivered only facts and figures without accounting for interacting or confounding factors. This dissertation aims to fill that gap most of all.

Chapter 2: Baltimore's History and Current Levels of Violence

Baltimore is a city in Maryland, United States, located about 40 miles northeast of Washington, DC. According to the US Census Bureau, Baltimore City has a population of 614,644 residents in 2016 (US Census Bureau, 2016b), an almost 100-year low (Sherman, 2017). Baltimore City began its history in the early 1700s as a port where tobacco and flour were routinely shipped overseas. During the Revolutionary War, Baltimore City expanded to become a shipyard for the new American Navy. By the early 1800s, trading inland expanded with the creation of a railroad line westward into Ohio, while manufacturing expanded along the Jones Falls. At the same time, the African American community in Baltimore City was the biggest in the United States, many of them free at the height of slavery. After the Civil War, Baltimore City remained a hub for building ships, shipping goods, and general manufacturing (Baltimore, 2006).

That large African American community in Baltimore City would see itself severely affected by the Great Depression. It was at that time that the Federal Home Owners' Loan Corporation (HOLC) began a practice of "redlining" certain districts in Baltimore City and not allowing financial incentives to flow into neighborhoods that were primarily African American (Sinn, 2017). These neighborhoods did not benefit as much as others from the New Deal projects that helped the country recover from the Great Depression. And, in many cases, these practices continued after the end of World War II, and their repercussions can be felt even today (Cooper, 2017).

In 2015, life expectancy in Baltimore City overall was 73.6 years, yet there is great variation in that number depending on the Community Statistical Area (CSA) being observed. For example, Clifton-Berea, a CSA located just north and east of the Johns Hopkins Hospital campus, has a life expectancy of 66.9 years and a median household income of $29,364 (Baltimore Neighborhood Indicators Alliance, 2018b). By comparison, Cross-Country/Cheswolde, a CSA located at the northwest edge of the city boundary, has a life expectancy of 87.1 years and a median household income of $55,964 (Baltimore Neighborhood Indicators Alliance, 2010). Pointing to the inequities brought on by institutional racism is the fact that Clifton-Berea has a population that is 94.5% African American while Cross-Country/Cheswolde's African American population is 19.1% of the total population. These inequities and inequalities continued to come up throughout the rest of this research, so much so that they had to be accounted for in the results of the analyses presented in the next chapters.

Homicides in Baltimore City Up to and Including 2014

According to information from the Federal Bureau of Investigation (FBI), the homicide rate in Baltimore City has been above 30 homicides per 100,000 residents since 1986, with levels above 40 homicides per 100,000 residents throughout the 1990s, and then a small decline at the beginning of the 2000s. Between 2003 and 2007, the rate increased above 40 homicides per 100,000 residents before dropping to 31 homicides per 100,000 residents in 2011, a low level not seen since 1986 (Federal Bureau of Investigation, 2018).

In 2002, an assessment from the Drug Enforcement Administration (DEA) in conjunction with the Baltimore City Police Department (BPD) concluded that heroin was the primary drug being used in Baltimore City and that it fueled violence in the city (National Drug Intelligence

Center, 1999). Furthermore, BPD estimated that 80% of homicides at that time were drug-related (Craig, 2000). In light of the recent opioid epidemic, these findings with regards to the sale and use of heroin continue to recent times.

Some of the decline seen leading up to and including 2011 was attributed to an overall decline in violent crime throughout the country. Officials in the Baltimore City government pointed to a concerted effort between different law enforcement and civic organizations in reducing crime in general, focusing especially on illegal drug trade (Fenton, 2012). However, according to FBI statistics, Baltimore City and a few other cities in the United States remained well above the rest of the country, and cities of similar size, when it came to the homicide rate (Federal Bureau of Investigation, 2018). By 2012, the homicide rate increased again, with 218 homicides reported in 2012, 233 in 2013, and 211 in 2014. The year 2015 would mark the beginning of a sharp increase in homicides and perhaps a new epidemic of violence.

The Freddie Gray Riots and Beyond

In April of 2015, a young man by the name of Freddie Gray, Jr. was arrested by BPD officers for possessing an illegal weapon, a switchblade. At some point during his transfer from the place of his arrest, located in the neighborhood of Sandtown-Winchester in western Baltimore City, Mr. Gray was injured and fell into a coma. One week later, life support was withdrawn, and he was pronounced dead. His death was ruled a homicide by the Office of the Chief Medical Examiner (Barajas, 2015), and six officers involved in Mr. Gray's arrest were indicted on various counts (Blinder & Perez-Peña, 2015).

From the time of Mr. Gray's death to the day of his funeral on April 27, 2015, tensions ran high in Baltimore City between city residents, including advocates for better police-

community relations, members of law enforcement, and leadership in the city's government. On April 25, a group of protesters marched to the Inner Harbor in downtown Baltimore City from City Hall. Some of the protesters turned violent, leading to 35 arrests and several police officers injured (Wenger & Campbell, 2015).

On April 27, a riot broke out in the western part of Baltimore City. It began when a group of young people, mostly students, were unable to board public transportation after school ended. Preemptive actions by the Baltimore City Police Department in anticipation of threatened violence closed down public transportation hubs near Mondawmin Mall (McLaughlin & Brodey, 2015). From there, the rioters marched south along major streets toward Sandtown-Winchester, breaking windows and looting stores along the way. Confrontations with police were many, leading to many arrests, many injuries to civilians, and many injured police officers (Yan & Ford, 2015). By the time the riot was brought under control, an estimated $9 million in damages had been caused (Toppa, 2015), over 200 people had been arrested, and several dozen had been injured (Hedgpeth, 2015).

That April, 22 homicides were reported in Baltimore City. The following May, a record 43 homicides were reported, surpassing the previous record for a month in Baltimore City of 42 homicides reported in August of 1990 (Puente, 2015). While there are some indicators that an acceleration in homicides had started before the riots of April 2015, there is a clear spike in the number of homicides from that date on that continued through the end of 2017. This spike seen in May of 2015 coincided with a drop in arrests by police (Associated Press, 2015). In 2014, a total of 46,232 arrests were reported by BPD. In 2015, that number dropped 29% to 32,939. For 2016, the number dropped even further to 25,432 arrests. And, in 2017, the number of arrests

dropped again to 24,260. Since 2005, the number of arrests in Baltimore City have dropped each year (Broadwater, 2018; Federal Bureau of Investigation, 2018).

According to an investigation by Reuters News Service (Malone, 2016), between 2015 and mid-2016, the Baltimore City Police Department saw a reduction of 360 officers in its force, about 12.8%. That same report quotes police union officials at the local and national level stating that morale is low because of the perceptions of the community toward officers stemming from the Freddie Gray incident and the associated riots. Nevertheless, BPD has been instituting new plans and incentives aimed at increasing the recruitment of new police officers (Duncan, 2017).

In April of 2017, a consent decree was issued by a federal court whereby BPD and the City of Baltimore would work toward repairing the rifts between the police force and the community (Baltimore Police Department, 2018). These rifts — the court found based on a Department of Justice (DOJ) investigation — were caused by a systemic and persistent culture within the department of violating civil rights of civilians, using excessive force, conducting stops and arrests deemed unlawful and unconstitutional. As the different plans are put into place to address these problems, the court will continue to monitor their progress in conjunction with DOJ.

Compounding some of these rifts with the community, eight members of the Gun Trace Task Force within BPD were indicted by a federal grand jury in 2017 (Broadwater & Rector, 2017). They were accused of crimes like racketeering and fraud stemming from unlawful arrests and seizures of property without probable cause. After these arrests, a drop of 67% in gun arrests was noted. By the end of 2017, arrests in general were down to their lowest level since the late 1990s (Broadwater & Duncan, 2017).

As **Figure 1.2** shows, the number of homicides per day reached almost one homicide per day almost a year to the day of the Freddie Gray Riots, indicating that there were close to 365 homicides in the 365 days following the riots. That number declined during the rest of 2016 only to see an increase in 2017 and a peak of almost one homicide per day in the 365 days previous to May 25, 2017, a far higher number than the one homicide every two days seen in the 365 days before May 5, 2012. (**Figure 1.2**)

Summary

Homicides in Baltimore City reached a low in 2011 with 196 homicides and a rate of 32 homicides per 100,000 residents, levels not seen since the 1970s (Federal Bureau of Investigation, 2018). This trend was reversed in 2012, 2013, and 2014 with 218, 233, and 211 homicides, respectively. Afterward, a severe spike in the number of homicides began in 2015 and continued through 2017, with 342, 318, and 343 homicides in those three years, respectively. In that same timeframe, Baltimore City has consistently been in the top 50 most violent cities in the world ("Seguridad, Justicia y Paz - CCSPJP," 2016.). In 2011, it ranked 48 out of 50. In 2015 and 2016, it ranked 26 out of 50, with only St. Louis, Missouri, as the other American city deemed more violent than Baltimore City.

While there is no clear single causative agent for the epidemic, a combination of individual characteristics, social characteristics, and environmental causes are likely at play. For example, individuals' participation in activities such as gang membership or the drug trade may not be sufficient to place them at higher-than-normal risk of victimization without living or frequenting a neighborhood deficient of police involvement or steeped in poverty. Or that elevated risk of victimization exists in a wealthy neighborhood if the individual practices

lifestyles that elevate that risk. To better understand this interplay, we will analyze individual social characteristics of the victims of homicide in Baltimore City between 2005 and 2017 using two available databases of victims, and several databases on neighborhood characteristics, demographics, and geography.

In Chapter 3, we will analyze homicide rate trends in order to confirm the existence of an epidemic of homicide in Baltimore City and characterize the victims of homicide killed before and during the epidemic. We will also seek to understand if there is a difference in how victims are killed based on those characteristics. In Chapter 4, we take the information on homicide locations and conduct a geostatistical analysis to identify any spatial and temporal patterns to the homicides. A statistical analysis on neighborhood-level environmental variables will be conducted to understand how those variables contribute to the average/expected number of homicides from one neighborhood to another, and from one year to another. And in Chapter 5, we conduct an inventory of some of the available violence prevention interventions in Baltimore City. We look at the overall strategy of the intervention, the areas of the city where the interventions are active, and how these characteristics fit into the findings of Chapters 3 and 4.

Chapter 3: Individual Social Characteristics of Homicide Victims in Baltimore, Maryland, from 2005 to 2017

Introduction

There is evidence that violence shares some of the characteristics of infectious diseases (Green et al., 2017). A person exposed to violence is more at risk of both perpetrating violence or being the victim of violence, and these exposures and increased risks travel through social networks (Tracy et al., 2016). From an epidemiological perspective, counts and rates of violent events in general and homicide in particular can be analyzed in terms of their distribution, magnitude and variance. The victims can be categorized into different epidemiologically distinct groups for which the risk of victimization can be studied and, in some cases, quantified. Much like with an epidemic of infectious disease, recommendations based on the evidence of these analyses can be made to guide the response.

Baltimore City has been among the most violent cities in the world since at least 2013, according to the annual list compiled by the Citizen Council for Public Safety and Social Justice.[3] The city has also been among the most violent in the United States when comparing fatal and non-fatal violent incidents per capita. Since 2015 — shortly after the events of the Freddie Gray Riots — Baltimore City has experienced a spike in the number of homicides and non-fatal shootings (Federal Bureau of Investigation, 2018). A detailed examination of the

[3] The *Citizen Council for Public Safety and Social Justice* (*Consejo Ciudadano para la Seguridad Pública y Justicia Social, A.C.)* is a civil society organization which runs a think tank to explore violence in all its dimensions. It is located in Mexico, and it has been publishing the list of top 50 most violent cities in the world every year since 2013. Details on the organization and its methodology can be found at: https://www.seguridadjusticiaypaz.org.mx/

characteristics of the victims is necessary to better understand the underlying processes leading to this exacerbation of violence and to suggest plausible solutions based on evidence.

We will begin with the examination of homicides in Baltimore City from an epidemiological perspective. First, we confirm the existence of an epidemic of homicide in Baltimore City through the examination of the counts and rates of homicides in Baltimore City between two time periods. The first time period, labeled the "non-epidemic" period for this study, is from 2005 to 2014. The second time period, labeled the "epidemic" period, is from 2015 to 2017. Next, we look at the demographic characteristics of the victims and the differences or similarities between the different groups of victims (e.g African American versus Hispanic). Finally, we look at the differences in the cause of death between the groups to show that, while very common for the overall picture of homicide in Baltimore City, the proportion of homicides by firearm is different by age, gender, race, and other individual characteristics.

Data Sources and Methods

The Institutional Review Boards of the Maryland Department of Health and the Johns Hopkins Bloomberg School of Public Health approved the research protocol for this work.

News Media-Derived Homicide Databases

Justin Fenton, a reporter at *The Baltimore Sun* has been keeping track of homicides in Baltimore City since 2004. The most recent homicide details, as well as a summary of previous years, is presented online to the public ("Baltimore Homicides," 2018). Mr. Fenton was contacted, and a request was made to obtain the entirety of the database from 2005 to 2016. He provided the data for those years in a spreadsheet. The data included the date of the homicide event, the street address, the name of the victim (if it was known), the age of the victim (if it was

known), the race of the victim (if it was known) and the gender of the victim (if it was known). A total of 3,066 cases were included in this database.

Mr. Fenton explained that cases were removed from the database if they were deemed to be justified. Cases were added based on the date of the event, or the date in which the homicide was ruled as such. For example, if a person was injured in 2004 and died of those injuries in 2005 — and their death was ruled a homicide — then the case was added as a 2005 case. However, for the purposes of this study, the year of the actual event/injury is the year to which we assigned the case. Also, we assigned gender and age to the victim records based on the narrative of the news reports. In the case of transgender victims, their gender was coded based on how they were identified in the news reports (e.g. "Female" if they were identified as "transgender woman" or "transgender female").

For the homicides occurring in 2017, a database was compiled from news reports and other official sources (e.g. Baltimore City Police Department press releases and social media postings). The date, street address, name, age, race and gender of the victims were compiled, if known. If the press or the police department mentioned the address block in which the victim was known to reside, that information was also collected. For previous years' victims, their home address block was only recorded if it was found during the verification process. A total of 337 homicides occurring in 2017 were then appended to the database provided by Mr. Fenton.

The verification process consisted of randomly selecting cases from the databases and searching news sources and Baltimore Police Department (BPD) press releases and social media postings. The information for the selected cases was compared between the databases and the published statements. A total of 347 cases were verified this way for the 2005-2016 cases,

resulting in the identification of 260 home addresses for victims, all at the block level. For 2017, 278 home addresses, also at the block level, were identified.

To calculate group-specific homicide rates by age group, gender, and racial/ethnic group, we used data from the US Census Bureau in the publication of census and population estimate data specific for Baltimore City. We used independent group t-tests to determine if there was a significant difference in the mean ages of the different groups. Chi-square tests and logistic regressions were used to compare the distribution of individual-level characteristics between groups. Statistical analyses were performed using Stata Statistical Software: Release 15 (StataCorp, 2017).

Maryland Violent Death Reporting System

The *Maryland Violent Death Reporting System* (MVDRS) is a surveillance system operated by the Maryland Department of Health in collaboration with the local health departments in Maryland. It is also a component of the wider National Violent Death Reporting System (NVDRS) operated by the Centers for Disease Control and Prevention (CDC) (Fowler, Jack, Lyons, Betz, & Petrosky, 2018). Deaths are classified into four categories: Homicides, suicides, deaths of undetermined manner, and legal interventions. The system began operating fully in 2003, and data from 2005 to 2015 was used in this analysis. The system uses reports from different sources in order to gain as much information as possible about the circumstances surrounding a violent death in Maryland.

For this combination active-passive surveillance system, the World Health Organization (WHO) definition for violent death is used: ***"A death resulting from the intentional use of physical force or power against oneself, another person, or against a group or community.***

The person using the force or power need only have intended to use force or power; they need not have intended to produce the consequence that actually occurred. "Physical force" should be interpreted broadly to include the use of poisons or drugs. The word "power" includes acts of neglect or omission by one person who has control over another." (Krug, Dahlberg, Mercy, Zwi, & Lozano, 2002) For this research, we are analyzing violent deaths from homicide, where a homicide is a death resulting from the intentional use of force from one person against another person or persons without legal justification. Reports are received and compiled from death certificates, the Office of the Chief Medical Examiner, law enforcement and healthcare providers — if the victims received some sort of medical care before their death (Centers for Disease Control and Prevention, 2016).

Data for this research consisted of 2,683 records on violent deaths from homicide within the boundaries of Baltimore City between 2005 and 2015. Both residents of the city and victims who resided outside the city were included in the analysis. Furthermore, the data were completely anonymized, and it was required by the Institutional Review Board that the data from the system would not be matched in any way to the information contained in the news-based database of homicides also presented in this chapter. Finally, because of previous knowledge of the demographic variability of the data in the Maryland Death Reporting System (Smith, Akinyemi, Stanley, & Mitchell, 2017), we performed an analysis of missing data to determine the proportion of data missing by variable and how those missing data were related to victims' characteristics.

Analysis

We calculated the homicide rate for Baltimore City from 1975 to 2017 by taking the official homicide count by year reported in the FBI Uniform Crime Report and the population

estimates from the US Census Bureau by year for Baltimore City, Baltimore County, Maryland, and the United States (Federal Bureau of Investigation, 2018). To see the influence on the homicide rate for Maryland that homicides in Baltimore City have, we subtracted the Baltimore City homicide count and the population of Baltimore City from the respective measures for Maryland. This resulted in homicide rates per year for the rest of Maryland, without Baltimore City. We then separated those rates into two time periods: An epidemic time period beginning in 2015 and an non-epidemic time period spanning the years before 2015.

From the news-based database, we analyzed the age, gender and race/ethnicity of the victims killed between 2005 and 2017. From MVDRS, we analyzed educational attainment, marital status, presence of alcohol or other drugs at the time of death, employment status, whether or not the injury occurred at home, and homelessness status. We also analyzed the cause of death. A detailed description of the variables and how they were individually analyzed can be found in Appendix B. (Appendix B)

If more than 10% of the records of a given variable were missing or unknown, we performed an analysis to identify demographic characteristics associated with the missing or unknown variables. This was the case for gang-involved homicides and educational level attained. All other variables had missing or unknown variables in a proportion less than 10%.

We further classified homicides into a binary category of *Firearm/No Firearm* where *Firearm* included all homicides in which the primary weapon used was a firearm of any kind. *No Firearm* homicides included *Stabbing* and *Other* as described above. This allowed for a logistic regression with *Firearm* as the dependent variable and the individual and social characteristics as

the independent variables. Crude and adjusted odds ratios[4], and their respective 95% confidence intervals and p-values, from this logistic regression were reported.

Results

Confirming the Existence of an Epidemic

The homicide rate in Baltimore City was at its lowest level in 1977, when it was 21 homicides per 100,000 residents. From there, the rate experienced a steady climb well into the 1990s. In 1993, the rate reached 49 homicides per 100,000 residents. A decline in the rate followed into the early 2000s, reaching 39 homicides per 100,000 residents in 2002. The rate climbed again to 44 homicides per 100,000 residents in 2007. By 2011, the rate dropped to 32 homicides per 100,000 residents, corresponding to 196 homicides, the first time the total homicide count was below 200 since 1978. The rate climbed again in 2012 and 2013 but dropped in 2014 to 34 homicides per 100,000 residents.

In 2015, the homicide rate climbed sharply to 55 homicides per 100,000 residents, corresponding with 342 homicides, a total count not observed since the 353 reported homicides in 1993. The rate remained elevated at 52 homicides per 100,000 residents in 2016 and reach a historical high of 56 homicides per 100,000 residents in 2017, corresponding to 343 reported homicides. Baltimore City has experienced a decline in the number of residents since the 1970s, from 860,695 residents in 1975 to 614,664 residents in 2016, a decline of over 246,000 residents (US Census Bureau, 2016a). **Figure 3.1** shows how, historically, the homicide rate for Baltimore City has been higher than that of Baltimore County, Maryland and the United States. When the homicide counts and population estimate for Baltimore City are removed from the Maryland

[4] Adjusted for Gender, Race and Age ≥18

homicide rate, the homicide rate for Maryland drops consistently below the homicide rate for the United States. (Figure 3.1)

The average homicide rate between 2005 and 2014 was 38 per 100,000 residents. Between 2015 and 2017, the average homicide rate was 54 per 100,000 residents. Between 2005 and 2014, during the "non-epidemic period" in this analysis, an average of 238 homicides per year were reported. Between 2015 and 2017, the "epidemic period" in this analysis, an average of 334 homicides per year were reported. (Table 3.1)

Seasonality of Homicides

The number of homicides in Baltimore City varied by month. Using the news-based database, we calculated the average number of homicide per month from 2005 to 2017. (Figure 3.8) May and July both averaged the highest number of homicides at 26, or about one homicide every 30 hours. On the other hand, February averaged the lowest number of homicides at 14, or about one homicide every 48 hours. **Figure 3.7** shows the periodicity of homicides by month between 2005 and 2017. (Figure 3.7)

Age

From the news-based database, we found that the age of the homicide victims between 2005 and 2017 ranged between 0 years (infants under one year of age) and 97 years. The average age was 30.5 years, 95% CI [30.1–30.9] for all victims, yet there were differences between the age distributions by gender, race and ethnicity, and combined gender and race and ethnicity. There was a significant difference in mean ages between males (mean = 30.2, 95% CI [29.8–30.6]) and females (mean = 33.0, 95% CI [31.0–35.0]). Male homicide victims were younger

than female homicide victims. The Years of Potential Life Lost (YPLL) during the entire study period totaled 145,520 years.[5]

There was a significant difference in the mean age of African American victims (mean = 30.0, 95% CI [29.5–30.4]) and non-African American victims (mean = 36.8, 95% CI [34.8–38.7]). There was also a significant difference in the mean age of white victims (mean = 39.2, 95% CI [36.9–41.6]) and non-white victims (mean = 30.0, 95% CI [29.6–30.4]). African American victims were younger than non-African American victims, while white victims were older than non-white victims.

A further breakdown of the data showed that African American male victims had the lowest mean age, 30, 95% CI [29.5–30.5], compared to other groups, except Hispanic female victims' mean age, 21.7, 95% CI [12.7–30.7], though the latter group consisted of 7 victims. White male victims had the highest mean age (40.4, 95% CI [37.6–43.2]) of all groups. This group's mean age was also significantly different from all others, except white female victims, whose mean age was 32.8, 95% CI [32.2–40.7]. (**Table 3.2**) (**Figure 3.4**)

Most homicide victims were in the 15-24 and 25-34 age groups, comprising 2,304 (68%) of all homicides between 2005 and 2017. The 0-14 and 65-and-over age groups were the smallest age groups by total count with 145 (4%) of all homicides between 2005 and 2017. Adjusted for population, the 15-24 age group had a consistently higher homicide rate throughout the study period, followed closely by the 25-34 age group. These two age groups, along with the 35-44 age group had homicide rates above the Baltimore City rate, with the exception of 2011 and 2013,

[5] While we had CSA-specific life expectancies for the victims based on the location of their homicide from the news-based database, we opted for the use of the Baltimore City life expectancy in order for future comparisons between Baltimore and other cities in the United States. Also, the victims may not have necessarily lived in the CSA where they were killed.

when the 35-44 age group had a rate slightly below that of the city. During the epidemic period, only the 15-24, 25-34 and 35-44 age groups experienced a significant increase in their homicide rate. The other groups remained steady and well below the homicide rate for the entire city. (**Figure 3.2**)

Gender

The majority of homicide victims (90%) were male. Males had a consistently elevated homicide rate throughout the study period compared to females and compared to the homicide rate in Baltimore City during the same time period. During the epidemic periods, males in the 15-24, 25-34 and 35-44 age groups showed a sharp increase in the homicide rate. At the same time, females of all age groups remained at relatively low homicide rates throughout the study period, without notable increases in rates and without surpassing the overall homicide rate for Baltimore City during the same time period. (**Figure 3.3**)

For male victims, 70% of all homicides were in the 15-24 and 25-34 age groups. In female victims, 50% of all homicides were in the 15-24 and 25-34 age groups. Female victims in the 0-14 age group constituted 10% of all homicides in females. Male victims in the 0-14 age group constituted 2% of all homicides in males. Similarly, female victims in the 65-and-over age group constituted 6% of all homicides in females. Male victims in the 65-and-over age group constituted 2% of all homicides in males. This distribution of homicides by age group between males and females was different than the distribution of males and females by age group in Baltimore City (2016 US Census estimate). (**Figure 3.5**)

Race

About 92% of the homicide victims reported between 2005 and 2017 were African American, with 2,861 (92%) of them being males. Adjusted for population, African American males had the highest homicide rate per 100,000 residents consistently across the study period. As **Figure 3.6** shows, African American males group also exhibited the sharpest increase during the epidemic period, rising from 956 homicides per 100,000 residents in 2014 to 1,672 homicides per 100,000 residents in 2015, 1,559 homicides per 100,000 residents in 2016, and 1,659 homicides per 100,000 residents in 2017.

Other groups, such as white males and females of all races, had much lower homicide rates throughout the study period. However, white males showed a relative increase in homicide rate during the epidemic period. That group went from 68 homicides per 100,000 residents in 2014, to 136 homicides per 100,000 residents in 2015, 126 homicides per 100,000 residents in 2016, and 193 homicides per 100,000 residents in 2017. (**Figure 3.6**)

Table 3.3 describes the homicide incidence rate by gender, race/ethnicity, and age group. It also describes the crude and age-adjusted incidence rates as well as the age-adjusted incidence rate ratio (IRR) and associated 95% confidence intervals. As the table shows, males had a significantly higher age-adjusted incidence than females, and African Americans had a significantly higher age-adjusted incidence than other racial/ethnic groups. In terms of age groups, the 15-24 and 25-34 age groups had sharply higher incidence rates than the other age groups. (**Table 3.3**)

Comparison between pre-epidemic and epidemic time periods

Individual social characteristics showed a slight increase in their proportion of the total homicide count between the pre-epidemic and the post-epidemic time periods. For example, the proportion of male homicide victims increased from 90% in the pre-epidemic period to 93% in the post-epidemic period. Two categories showed a change greater than 5%: the 15-24 age group, with a decrease in the proportion of homicides from 36% to 30%; and the proportion of homicides by firearm, with an increase from 81% to 86%. The comparison of the odds of homicide between the pre-epidemic and epidemic periods, stratified by gender, race, age and death by firearm, showed that only the odds of homicide by firearm were significantly higher in the epidemic period compared to the pre-epidemic period. (**Table 3.8**) (**Table 3.9**)

Results from the Maryland Violent Death Reporting System

A total of 2,670 (99.5%) of victims reported to the MVDRS had an autopsy performed by the Office of the Chief Medical Examiner. This allowed for several indicators to be fully reported to the system, such as the victims age, gender, race, height, weight, and toxicology results. Other information was received from law enforcement and from extracting data from death certificates. Table 2.4 summarizes the findings with regards to personal and social characteristics and demographic characteristics of the victims. (**Table 3.4**)

The educational level was available for 2,012 (75%) of the homicide cases between 2005 and 2015. Most of the victims for whom an educational level was known had completed a high school diploma or equivalent. About 38% of adults had not completed a high school education. None of the victims had completed a graduate degree. A logistic regression on a binary variable of No High School / At Least High School showed that African American victims had

marginally higher odds of at least a high school diploma or GED when controlling for gender (OR = 1.44, 95% CI [1.04–2.98]). No other demographic variable was associated with having completed at least a high school diploma or GED.

Gang involvement information was available for 1,976 (74%) of homicide victims. Of those, 34 (2%) were identified as gang-involved homicides. Males constituted 33 (97%) of those 34 homicides. All of the gang-involved homicide victims were African American.

Testing for alcohol was not fully implemented until 2012. As a result, we limited the analysis of toxicology results to those victims killed between 2012 and 2015 (n=987). Of those, 944 (96%) had toxicology results reported. The plurality of victims (37%) had no substances found. A further 27% had at least alcohol found, while 36% had substances other than alcohol found. **Appendix C** contains a list of the substances other than alcohol found in the victims. Some of those substances are drugs of abuse or illicit drugs while many are not. (**Appendix C**)

The majority (68%) of homicide victims were employed. This proportion was constant across gender and racial/ethnic groups. There was no significant difference in the proportion of employment between male and female victims. However, when comparing white to non-white victims, employed victims had higher odds of being white, OR = 1.48, 95% CI [1.01–2.17].

The majority (85%) of homicide victims were killed away from home. Victims killed at home had significantly higher odds of being women, while adjusting for race and intimate partner violence (OR = 5.98, 95% CI [4.40–8.13]). They also had significantly higher odds of being white, while adjusting for gender and intimate partner violence (OR = 1.69, 95% CI [1.11–2.59]). And victims killed at home also had significantly higher odds of being the victims of intimate partner violence, while adjusting for gender and race (OR = 3.31, 95% CI [1.98–5.52]).

A total of 85 (3%) of homicide victims were reported to have been killed as a result of intimate partner violence. Of those, 58 (68%) were female, 71 (84%) were African American, and 83 (98%) were 18 years of age or older. Adjusting for race/ethnicity and age ≥18, females had significantly higher odds of being victims of intimate partner violence (OR = 25.5, 95% CI [17.4–46.7]).

Of the adult victims included in the study, 268 (10%) were married at the time of their homicide. Another 1,983 (74%) were never married and 175 (9%) were divorced, separated, or widowed. Stratifying by gender, females had a higher proportion of married victims, 16%, compared to males, 9%. Stratifying by race, Hispanic victims had a higher proportion of married victims, 30%, yet married Hispanic victims constituted less than 1% of all victims. By comparison, 14% of white victims were married, and 9% of African American victims were married.

A logistic regression on a binary variable for marriage (*Married*/*Not Married*) with independent variables for gender, race and ethnicity showed that females had significant higher odds of being married (OR = 1.85, 95% CI [1.27–2.71]), controlling for race and ethnicity. Neither race nor ethnicity were significantly associated with being married. A further logistic regression showed that married victims had significant higher odds of being victims of intimate partner violence, adjusting for gender and race (OR = 3.11, 95% CI [1.77–5.46]).

A total of 22 (0.8%) of homicide victims were identified as homeless. However, this is a number lower than the number of homicide victims for whom homelessness could not be determined, 84 (3%). Of those 22 homeless victims, all were adults (median age 45), 19 (86%) were male, and 17 (77%) were African American.

Variables with Missing or Unknown Values

An analysis of the missing data on educational attainment was performed with a binary Missing/Not Missing variable on the 714 (25%) of homicide victims. Only gender was associated with the variable being missing, adjusting for race/ethnicity and age ≥18, with females having higher odds of their educational level being missing (OR = 1.46, 95% CI [1.09–1.91]). A different analysis of the data on gang-related homicides used a binary Known/Unknown variable and showed that the 707 (26%) victims for which gang involvement was unknown were more likely to be male (OR = 1.60, 95% CI [1.14–2.24]), African American (OR = 1.72, 95% CI [1.21–2.46]), and adults (OR = 2.11, 95% CI [1.38–3.20]), with each variable controlled for the others.

Homicides by Firearm

Using the news-based database, firearms accounted for 2,779 (83%) of all homicides reported between 2005 and 2017. In the pre-epidemic period, 81% of homicide victims were killed by firearm. In the epidemic period, 86% of homicide victims were killed by firearm. The odds of homicide by firearm were significantly higher in the epidemic period, OR = 1.51, 95% CI [1.22–1.85].

The mechanism of injury also varied by age group. Of the 79 homicides reported within the 0-14 age group, 20 (25%) homicides by firearm, and 56 (71%) were via other mechanisms of injury (e.g. asphyxiation, blunt force trauma, or drowning). In the 65 and over age group, homicides by firearm represented the plurality of homicides with 19 (29%). In that same age group, 18 (27%) homicides were by stabbing, and 29 (44%) homicides by other mechanisms. However, in the 15-24, 25-34, 35-44 and 45-64 age groups, firearms constituted the majority of

homicides within each age group, constituting as much as 91% of homicides in the 15-24 age group and 90% in the 25-34 age group.

Stratified by gender, there is an almost equal distribution of homicides by firearm and stabbing/other means in females, with 51% of female homicide victims killed by firearms and 49% from non-firearm causes. In contrast, males had significantly higher odds of being firearm homicide victims, adjusting for race/ethnicity and age (OR = 4.90, 95% CI [3.77–6.36]). About 86% of male homicide victims were killed by firearm, 8% by stabbing, and 6% by other mechanisms. **Table 3.5** details the differences in proportions of mechanism of injury by gender, race/ethnicity, and age group. (**Table 3.5**)

Using MVDRS, we determined the counts and proportions of homicides by different mechanism of injury and individual social characteristics. As with the data from the news-based database, most of the victims (81%) were killed by firearm. This proportion varied slightly in most of the individual social characteristics. However, some characteristics demonstrated a smaller proportion of homicides by firearm. For example, 54% of victims whose homicides occurred at their homes were killed by firearm. Victims of intimate partner violence also had a low proportion of homicides by firearm at 38%. Also, 41% of victims identified as homeless were killed by firearm. **Table 3.6** details the differences in proportions of mechanism of injury by individual social characteristics. (**Table 3.6**)

When all the individual social characteristics were categorized into binary variables, we calculated the odds of firearm homicide for each characteristic and the associated odds ratios, crude and adjusted for gender, race/ethnicity and age ≥18. We found that the odds of homicide by firearm were significantly higher for males, African Americans, and adults. The odds of

homicide by firearm were significantly lower for victims with alcohol detected in the toxicology report at autopsy, victims who were employed, victims killed at home, victims of intimate partner violence, and homeless victims. Table 3.7 details the crude and adjusted odds ratios for the odds of being victims of homicide by firearm. (**Table 3.7**)

Discussion

Baltimore City is experiencing a homicide epidemic that began sometime in April of 2015. Even with historically high levels of violence compared to the rest of Maryland and the United States, a clear exacerbation of violence was observed in 2015 based on homicide counts and their associated per capita rates. This exacerbation manifested itself in significantly higher odds of a victim being killed by a firearm than by other means, though there were no observed significant differences in other individual social characteristics between the pre-epidemic and the epidemic time periods. The circumstances that triggered this epidemic — or are sustaining it — are not well understood. Nevertheless, the findings presented in this research do lead to better understanding of who has been a victim of homicide in Baltimore City between 2005 and 2017.

The average victim of homicide in Baltimore City between 2005 and 2017 was male, African American, and between the ages of 15 and 34. They graduated high school and had some sort of employment. Alcohol and/or other substances were found in the toxicology tests at the time of their autopsy, and they were killed away from their homes. They were also killed by firearm. During the epidemic period of homicides in Baltimore City, African American males ages 15-44 showed the highest spikes in homicide rates compared to the pre-epidemic period. All other age group/gender/race combinations remained at similar levels compared to the pre-epidemic period.

Deviations from these findings are seen in victims killed at home. They were more likely to be female and to be victims of intimate partner violence. These findings with regards to female victims in Baltimore City somewhat mirror recent findings on a national level where about half of all female victims were killed by an intimate partner (Petrosky et al., 2017). This as the homicide rates for females in Baltimore City, stratified by age group and race, remain at similar levels compared to the pre-epidemic period, and at levels lower than the overall homicide rate for the city.

Like any other public health surveillance system, the MVDRS is not without limitations. A 2017 analysis of the system's data found that circumstances surrounding the violent death were recorded in the system for 53% of the deaths, and that this lack of knowledge or recording of circumstance data was more likely to be found in certain demographic groups deemed most at risk of violent death (Smith et al., 2017). That analysis concluded that "***...groups most affected by fatal violence may be less likely to benefit from research conducted with these data because of decreased data completeness. Given that for some demographic groups, circumstance data for homicides are missing for more than half of cases, there may be important factors underlying these incidents that cannot yet be determined.***" Indeed, in our analysis of the data, we found that certain variables were more likely to be missing if the victim was male and/or African American. Nevertheless, the fact that over 99.5% of homicide victims reported in the MVDRS had an autopsy performed shows that almost all victims are coming into contact with law enforcement, showing that case ascertainment is probably not a problem while obtaining information on the circumstances of the homicide is.

Our analysis of the data in the MVDRS found that most of the victims had at least a high school diploma or equivalent. This could be explained by two factors. First, the graduation rate

in Baltimore City in recent years has been well above 60% and even reaching 70% in the most recently available data (Baltimore City Public Schools, 2017), and, second, Maryland law makes attendance to school compulsory for children under 16 years of age.[6] Despite this, one must make note that most of the victims of homicide in Baltimore City were beyond high school age, and very few of the victims were currently enrolled in high school at the time of their death. Furthermore, the proportion of homicide victims with at least some college education was very small, and none of the victims were reported to have a college degree. Based on these findings, we recommend further studies to explore the relationship between education and victimization in Baltimore City, theorizing that educational attainment beyond high school may be a protective factor against victimization.

Comparison of the MVDRS and the news-based database showed that the total number of homicides were not much different between the two databases. The number of homicides counted in each database also matched closely with the FBI Uniform Crime Report data. Furthermore, the rates of homicide by demographic characteristics were also similar. The small differences may be explained by the data collection practices between the two systems. As previously explained, the MVDRS relies on reporting from law enforcement and the Office of the Chief Medical Examiner as the primary sources of data. From time to time, a homicide reported in the news media has been changed from a criminal homicide to a justified homicide, for example. Such an instance would not be included in the MVDRS database as we requested only non-justified homicides to be included for our analysis. Another example could be a suicide that is not reported in the media but is then classified as a homicide after further investigation,

[6] Md. Code. Education §7-301

and vice-versa, where a homicide could be later classified as a suicide — or some other manner of death — once law enforcement and the medical examiner have conducted their investigations.

When making comparisons from one year to the next, one must be careful to observe the apparent periodicity of homicides. For example, comparing the number of homicides in the first 100 days of a year to the first 100 days of the previous year may lead to inadequate conclusions if the conditions contributing to homicides, including weather and social phenomena, are not comparable between those two time periods. As there is some evidence that weather plays a part in the incidence of violence, (Michel et al., 2016) one must be careful to recognize all the factors that contribute to levels of violence. This is important to keep in mind when planning for staffing at police departments, hospitals, and other institutions that deal with victims of violence.

Even comparisons at shorter time intervals could be confounded by the same factors discussed above in addition to other, less explored factors like the phenomena of the Hawkes process. In that process, the incidence of one event — such as a homicide — increases the odds of a similar event happening closely in time and space by the very nature of the event (G. Mohler, 2013). For example, a homicide associated with a gang dispute may trigger more homicides or other acts of violence in retaliation shortly after the first incident and in the neighborhood or general vicinity of the first incident. That second incident may trigger a third, and so on until some competing or opposing force — like increased police action or the exhaustion of viable victims — stops the event cluster (G. O. Mohler, Short, Brantingham, Schoenberg, & Tita, 2011).

In terms of demographics, 92% of homicide victims killed between 2005 and 2017 were African American. This as the estimated percentage of Baltimore City residents reporting their

race as “Black or African American alone” in 2016 was estimated to be around 63% (US Census Bureau, 2016a). This shows a clear disparity with regards to victimization tilted against African Americans. While the MVDRS does not report income or poverty characteristics at an individual level, African American residents of Baltimore City do tend to be poorer and more unemployed compared to their non-African American counterparts (Asante-Muhammad, 2017). Further studies on the gradience of wealth and homicide victimization in Baltimore City are also suggested.

Finally, it should be noted that Hispanics are a rapidly-growing group in Baltimore City, going from 1.7% of the population in the 2000 census, to 4.1% of the population in the 2010 census. They are now an estimated 5.1% of the population, according to the most recent population estimate reported by the US Census Bureau (US Census Bureau, 2016b). However, this ethnic group did not experience a spike in homicides like other groups did, even when stratified by gender and age. It would be worthwhile to study the individual social characteristics of Hispanics in Baltimore City. Even their cultural or group-level social characteristics may help better understand why they did not show a spike in homicides beginning in 2015 but remained relatively steady, just like white residents of the city did as a group.

Chapter 4: Contribution of Environmental Characteristics of Community Statistical Areas to the Frequency and Spatial Distribution of Homicides in Baltimore, Maryland, Between 2005 and 2017

Introduction

According to FBI statistics, slightly over 5,200 homicides were reported to law enforcement in 2016 in the United States (Federal Bureau of Investigation, 2017). About 4,700 of those victims were adults, about 3,900 were male, and it was an almost even split between White and African American victims. This as African Americans make up about 13% of the United States population (US Census Bureau, 2016b). According to *The Economist*, most homicides are concentrated in cities, where there is also the highest concentration of people and crime (The Economist, 2017). For the most part, these homicides are in singles or pairs, or maybe even three people at a time. It is very rare to see four or more victims, though those are the events that catch national attention precisely because they are rare or occur in a public place, like a school (Krouse & Richardson, 2015).

While we understand individual social characteristics of homicide victims because plenty of information is available on them through law enforcement and news media coverage, we still have a limited understanding of the interplay of neighborhood-level characteristics and the risk of homicide victimization. For example, there is an association between crime and poverty (Sharkey, Besbris, & Friedson, 2017). Even with the strength of that association, it is very

difficult to know which came first, the crime or the poverty. It may be that an area became impoverished when the criminal element scared away employers, businesses, and people with enough wealth to move away from the crime. Or an area could have been peaceful until wealth declined for whatever reason, and that decline of wealth and opportunity somehow forced the residents to turn to crime.

The association between crime and poverty is also not necessarily a linear one. Just because a place has high levels of poverty doesn't predict that it will have high levels of crime. A place with low poverty could have high crime while a place with high poverty could be relatively peaceful. But public health practitioners look closer at the bigger picture of the exposure-outcome association at a population level.

Furthermore, this relationship can be confounded by poverty's association with other indicators, such as education (Hall & Lee, 2013). Education is also associated with crime in an inverse way (Lochner & Moretti, 2004). So we would have to look at that association in order to tease out the true effect of each indicator on crime at the neighborhood level, while still accounting for the effect of individual characteristics on overall homicide counts. For this, we have several options including regression models and geostatistical analyses. We will use the former to analyze the indicators' contribution to the variance in homicide counts between Community Statistical Areas (CSA). Finally, we will also use the Geographic Information System to spatially explore differences in homicide rates and neighborhood-level indicators between CSAs as well as to identify incident hot spots at a citywide level.

Data Sources and Methods of Analysis

The Institutional Review Boards of the Maryland Department of Health and the Johns Hopkins Bloomberg School of Public Health approved the research protocol for this work.

Baltimore Neighborhood Indicators Alliance Data

The *Baltimore Neighborhood Indicators Alliance-Jacob France Institute* (BNIA-JFI) is a unit within the University of Baltimore. The unit's main goal is "to provide open access to meaningful, reliable, and actionable data about, and for, the City of Baltimore and its communities." (Baltimore Neighborhood Indicators Alliance - Jacob France Institute, 2018). To this end, BNIA-JFI collects data on different indicators about Baltimore City from different sources at all levels of government, civil society, and private/public organizations. These indicators range from demographic data collected from the US Census Bureau to indicators about urban health, such as abandoned/empty housing or crime statistics. The organization uses CSAs instead of neighborhoods because CSAs are more stable over time while still maintaining the underlying characteristics of the neighborhoods that compose it even as the neighborhoods may change in terms of size or boundaries (Baltimore Neighborhood Indicators Alliance, 2018a). These data are compiled and reports on a periodic basis by BNIA-JFI in a *Vital Signs* report. The data are also openly available for download at the organization's website.

US Census Bureau Data

Population counts and estimates were obtained from the US Census Bureau via their website. Through their American Community Survey (ACS) performed annually, the Bureau keeps an estimate of the population distribution of Baltimore City. This distribution can be broken down by age, gender, race/ethnicity and other variables.

Baltimore City Open Data

The Baltimore City Government operates an online depository of publicly-available data published by different departments.[7] The data are available through a Creative Commons Attribution 3.0 Unported license. As a result, the data are available for public and private use so long as the user(s) agree to the Terms of Use (City of Baltimore, 2018). From these datasets, we obtained data on fatal and non-fatal shootings occurring in the city, as well as geographic shapefiles related to the schools, neighborhoods, and CSAs of the city.

NIfEty Data

The Neighborhood Inventory for Environmental Typology (NIfETy) is a method of quantifying a neighborhood's physical and social characteristics using standardized means (Smart, 2008). The method includes an assessment tool and accompanying training as well as quality control measures. For this research, we obtained CSA-level NIfETy indices on physical disorder, youth activity, violence, and mobility. To develop these indices, 446 random blocks in 272 residential Neighborhood Statistical Areas in Baltimore were surveyed. "Residential" areas were defined as those areas with 100 or more residents. Those values for the Neighborhood Statistical Areas were then aggregated to their corresponding CSAs. Definitions of these indices can be found in **Appendix A**. (**Appendix A**)

Analysis of Neighborhood and Homicide Data

We calculated homicide rates per 100,000 residents for the 55 different CSAs for the entire study period by using the homicide counts from the news-based database as numerators and an average of the US Census population estimates of those CSAs for each year as

[7] Open Data Program. City of Baltimore. ART. 1, § 9-1

denominators. The year-specific counts and population were used for year-specific homicide rates.

We used the methods described by Schneider et al to calculate a concentration curve and associated Gini index for the 55 CSAs over the entire study period (Schneider et al., 2004). We then did the same for each year within the study period. This was done by ordering the CSAs from lowest to highest proportion of households living under the poverty line. The resulting Lorentz curves (one for the study period and 13 for each year within the study period) were plotted in order to give a graphical display of the inequality in the burden of homicides between the poorest and the wealthiest CSAs in Baltimore City.

We took data from BNIA-JFI on the proportion of family households living under the poverty line, proportion of vacant housing, median household income, high school completion rate, population density, and the racial diversity index. We also took the NIfETy indicators for physical disorder and youth activity. We calculated Pearson correlation coefficients for the variables to assess for correlation and to prevent collinearity in the negative binomial model. We chose a negative binomial model because we discovered overdispersion in the distribution of homicide counts by CSA. The mean was 61.2 homicides per CSA while the variance was 2,486, violating the requirement of a Poisson distribution in the counts. As a result, a Poisson regression was not proper, leading to the negative binomial regression.

For that regression, we used a model with the number of homicides per CSA as the dependent variable. We used the average population for the CSA over the study period as the offset to calculate the outcome as a homicide rate. The independent variables were the CSA-level variables we obtained from BNIA-JFI. The final model was selected in a stepwise manner with

forward selection of significant variables. All statistical analyses were performed using Stata Software: Release 15 (StataCorp, 2017).

Analysis of Geographic Data

We conducted a cluster and outlier analysis of the CSAs and their average homicide rates for the entire study period. Because of the differences in the hot spots between the pre-epidemic and the epidemic time period, we constructed a time cube in order to visualize the changes in homicide counts by CSA year-by-year between 2005 and 2017. The *time cube* data was then used for an emerging hot spot analysis of the point (homicide location) data to identify new, consecutive, intensifying, persistent, diminishing, sporadic, oscillating and historical hot spots or cold spots and their associated Getis-Ord Gi* statistics.[8] We then repeated the process but only for homicide incidents in which the victim was African American, male, between the ages of 15 and 35, and killed by a firearm. These characteristics were chosen because, in our findings from the first aim, this group represents an epidemiologically distinct group from other homicide victims in Baltimore City.

To account for the spatial autocorrelation in our negative binomial model, we created a variable to quantify the average number of homicides in neighboring CSAs. This was done by looking at a CSA and its neighbors, then counting the number of homicides in the neighbor CSAs and dividing that number by the number of neighbor CSAs. This *average homicides in neighbors* was included as an independent variable in our models (Jones-Webb & Wall, 2008).

[8] Definitions of these hot spot and cold spot categories are given as footnotes in the results section and also included in Appendix A. A visualization of these categories is available as **Figure 4.4**.

We also analyzed the number of homicides by firearm near public schools in Baltimore City. We defined a radius of 1,000 feet around the schools and counted the number of homicides by firearm within that radius. This radius was chosen as it is the distance within which guns are not permitted to be carried according to the Federal Gun-Free School Zones Act.[9] (Gun-Free School Zones Act of 1990)

Finally, we had home block-level addresses for 302 victims who were Baltimore City residents and were not killed at their place of residence. We conducted a distance traveled network analysis using walking distances from the victims' homes to their respective homicide locations. We used walking distances as these represented the minimum distance traveled by victims, knowing that they may have traveled a longer distance by using public transportation or driving. We then conducted a linear regression to estimate the average distance traveled by a victim controlling for their age, gender, race and cause of death.

All geographic analyses were done using ArcGIS.[10]

Results

Homicides by Community Statistical Area

During the study period, 2005-2017, all 55 CSAs in Baltimore City had at least two homicides. The average number of homicides per CSA in Baltimore City was 61 homicides. The range of homicide counts by CSA was 2 (Cross-Country/Cheswolde and Mount Washington/Coldspring) to 209 (Greater Rosemont). In terms of a yearly homicide rate, the

[9] Gun-Free School Zones Act of 1990, 18 U.S.C. § 921.

[10] Maps throughout this work were created using ArcGIS® software by Esri. ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under license. Copyright © Esri. All rights reserved. For more information about Esri® software, please visit www.esri.com.

lowest rate was in Cross-Country/Cheswolde with 1.2 homicides per year per 100,000 residents. The highest rate was in Midway/Coldstream with 101 homicides per year per 100,000 residents. According to the news-based database, Baltimore City experienced 3,366 homicides during the 13 years of the study period, equaling a yearly rate of 41 homicides per year per 100,000 residents. (**Map 4.1**)

Comparing the yearly average homicide rates per 100,000 residents between the pre-epidemic (2005–2014) and epidemic (2015–2017) time periods, 16 CSAs showed a decline in the yearly homicide rate per 100,000 residents. The largest decline was seen in Cherry Hill, where the pre-epidemic yearly homicide rate was 55 homicides per 100,000 residents. During the epidemic period, the yearly homicide rate was 37.5 homicides per 100,000 residents, a difference of 17.5 fewer homicides per year per 100,000 residents. On the other hand, the other 39 CSAs exhibited an increase in yearly homicide rates per 100,000 residents. Poppleton/The Terraces/Hollins Market had the highest increase, with a yearly homicide rate of 56 homicides per 100,000 residents in the pre-epidemic period and 141 homicides per 100,000 residents in the epidemic period. (**Map 4.2**)

Concentration Curve of Homicides Based on Median Household Income

A concentration curve of the cumulative number of homicides against the percent of households living under the poverty line shows a tendency towards inequality in the distribution of homicides. As **Figure 4.1** shows, the 18 poorest CSAs accounted for 50% of the homicides that occurred during the study period. At the other end of the wealth spectrum, the 18 wealthiest CSAs accounted for about 10% of the homicides that occurred during the same time. This inequality in the distribution of homicides was similar year after year. The Gini Coefficient, a measure of inequality among the frequency distribution of homicides when CSAs are ranked in

order of increasing poverty, was higher in some years than others, but stayed near the average for the whole study period, as shown in **Figure 4.2**. (Figure 4.1)(Figure 4.2)

Spatial Autocorrelation

An analysis of the spatial autocorrelation of the homicide rates by CSA showed yielded a Moran's I Index of 0.221, z-score = 5.515, $p \leq 0.001$. Based on these results, there is a less than one percent chance that the clustering of homicides observed is the result of random chance. These results are consistent with some spatial autocorrelation of the homicide rate values at the CSA level. Observed in this analysis were two clusters of CSAs with low homicide rates between CSAs with higher homicide rates in Midtown and The Waverlies. There were also four CSAs with low homicide rates clustered in areas where the homicide rate was low. These were Chinquapin Park/Belvedere, Greater Roland Park/Poplar Hill, Hamilton and Loch Raven. (Map 4.3)

Negative Binomial Regression Based on Neighborhood Indicators from BNIA and NIfETy

We obtained Pearson correlation coefficients of the neighborhood indicators obtained from the BNIA-JFI and NIfETy datasets. Several of the indicators showed strong correlations while others, such as the percent of households below the poverty line and population density, were not as strong. This, along with our knowledge of the constituent components of the indicators, informed our selection for the negative binomial regression. (Table 4.1)

For the negative binomial regression, we chose the variable for percent of households living below the poverty line instead of the median household income. We did this based on the finding by Krieger et al, that the percentage living below poverty is more indicative of the level

of poverty in a neighborhood (Krieger, Chen, Waterman, Rehkopf, & Subramanian, 2005). Using a stepwise selection of variables in building the final model, we chose percentage of households living under the poverty line and the index of physical disorder as the final independent variables to be used based on their statistical significance after adjusting for the other variables. These variables are presented in **Table 4.2**. (Table 4.2)

The negative binomial regression showed that the incidence rate ratio was statistically significant for the two variables. That is, for each increase of 10% in the percentage of households living under the poverty line in a given CSA, there is a 21% increase in the incidence of homicides, adjusting for the index of physical disorder, IRR = 1.21 (1.04–1.40). Likewise, for each increase of one unit in the index of physical disorder in any given CSA, there is a 47% increase in the incidence of homicides, adjusting for poverty, IRR = 1.47 (1.30–1.66). Our sensitivity analysis, using average homicides in neighbors to account for spatial autocorrelation, did not significantly change the results of the negative binomial regression. We include in the maps section two maps displaying the spatial distribution of the percentage of households living under the poverty line and the index of physical disorder. (Map 4.10)

Physical Disorder and Poverty Change Between Non-Epidemic and Epidemic Periods

Nine of the 55 CSAs in Baltimore showed an absolute increase in the average yearly proportion of vacant housing of more than 1% between the non-epidemic (2005–2014) and epidemic (2015–2017) time periods in our analysis. Nineteen CSAs showed a decrease in the average yearly proportion of vacant housing between the two periods. Vacant housing was used in this instance as a surrogate for physical disorder to compare the physical disorder status between the two time periods among the CSAs in Baltimore. **Map 4.11** shows the spatial

distribution of the change in average yearly proportion of vacant housing by CSA between the two time periods. (**Map 4.11**)

Furthermore, 19 of the 55 CSAs in Baltimore showed an absolute increase in the yearly average proportion of households living under the poverty line of more than 1% between the two time periods. Twenty-six of the 55 CSAs showed an absolute decrease. **Map 4.12** shows the spatial distribution of the change in average yearly proportion of households living under the poverty line by CSA between the two time periods. (**Map 4.12**)

Geographic and Geostatistical Analysis of Homicides by CSA

Incident Hot Spots and Cold Spots

Using an optimized hot spot analysis on the point data for each homicide location in the entire study period, we found several distinct hot spots of homicides. As Map 4.3 shows, two large hot spots — areas where the homicide counts are clustered beyond what is expected by random processes — exist in East and West Baltimore City. One medium-sized hot spot was detected in Northwest Baltimore City, mainly in Pilmico/Arlington/Hilltop and Southern Park Heights. Small hot spots were detected in Belair-Edison, Brooklyn/Curtis Bay/Hawkins Point, Cherry Hill, and Forest Park/Wallbrook. One additional hot spot was detected straddling Allendale/Irvington/S. Hilton and Edmondson Village. There were no cold spots — areas where the homicide counts were dispersed beyond what is expected by random processes. (**Map 4.4**)

These homicide incident hot spots were not consistent across time. When the homicides were classified as pre-epidemic (2005 to 2014) and epidemic (2015 to 2017) homicides, the resulting hot spots detected were different. As **Map 4.5** and **Map 4.6** show, the two main hot spots over East Baltimore City and West Baltimore City remain, yet the smaller hot spots are

different in size. For example, the hot spot in Northwest Baltimore City is more concentrated in Pimlico/Arlington/Hilltop during the epidemic period. Also during the epidemic period, the hot spot detected in Cherry Hill is nonexistent while a small hot spot emerges in Greater Govans and the Belair-Edison hotspot diminishes. (**Map 4.5**) (**Map 4.6**)

Time Cube and Emerging Hot Spot Analysis

The time cube analysis showed the difference in homicide counts by year between the 55 different CSAs. While some areas displayed continuously elevated homicide counts, others showed elevated homicide counts at only several years between 2005 and 2017. Based on these findings, we performed an emerging hot spot analysis to identify hot spots or cold spots based on the variance of homicide counts over the 13 years in the study period. (**Figure 4.1**)

The emerging hot spot analysis of the entire study period (2005 to 2017) showed that the two major hot spots over West Baltimore City and East Baltimore City are mostly persistent hot spots.[11] Within the hot spot in West Baltimore City, mostly over Upton/Druid Heights and Sandtown-Winchester/Harlem Park, there is a large area of intensifying hot spots.[12] There are also intensifying hot spots in an area straddling Pimlico/Arlington/Hilltop and Southern Park Heights. New hot spots were detected in Greater Govans and in the southwest edge of the larger hot spot in West Baltimore City.[13] A large number of sporadic hot spots, with a few new hot

[11] A **persistent hot spot** is "(a) location that has been a statistically significant hot spot for ninety percent of the time-step intervals with no discernible trend indicating an increase or decrease in the intensity of clustering over time."

[12] An **intensifying hot spot** is "(a) location that has been a statistically significant hot spot for ninety percent of the time-step intervals, including the final time step. In addition, the intensity of clustering of high counts in each time step is increasing overall and that increase is statistically significant."

[13] A **new hot spot** is "(a) location that is a statistically significant hot spot for the final time step and has never been a statistically significant hot spot before."

spots, were detected in Brooklyn/Curtis Bay/Hawkins Point.[14] No hot spots were detected in Cherry Hill, a CSA in which optimized hot spot analysis for the entire study period had detected a hot spot, but the same optimized hot spot analysis did not detect a hot spot during the epidemic time period. (**Map 4.7**)

The emerging hot spot analysis using only homicide incidents where the victims were male, African American, between the ages of 15 and 35, and who were killed by firearm showed only hot spots. There were no cold spots identified in that analysis. New hot spots were detected in Brooklyn/Curtis Bay/Hawkins Point, Greater Govans, and in the area where Howard Park/West Arlington borders Dorchester/Ashburton and Forest Park/Walbrook. In West Baltimore City, sporadic hot spots surrounded the persistent hot spot. A small diminishing hot spot could be observed west of the larger hot spot.[15] However, in the center of the larger hot spot in West Baltimore City, there are two intensifying hot spots. In East Baltimore City, the larger persistent hot spot is also surrounded by a sporadic hot spot. However, at the center of that larger hot spot is an area identified as a diminishing hot spot. (**Map 4.8**) (**Table 4.3**)

Analysis of Homicides by Firearm Within 1,000 feet of Public Schools

We created a buffer of 1,000 feet around the 190 existing public schools in Baltimore City. We then counted the number of homicides that were reported within those buffer zones. In total, 1,261 homicides were reported within those zones. That is 35.5% of all homicides reported in the study period.

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[14] A **sporadic hot spot** is "(a) location that is an on-again then off-again hot spot. Less than ninety percent of the time-step intervals have been statistically significant hot spots and none of the time-step intervals have been statistically significant cold spots."

[15] A **diminishing hot spot** is "(a) location that has been a statistically significant hot spot for ninety percent of the time-step intervals, including the final time step. In addition, the intensity of clustering in each time step is decreasing overall and that decrease is statistically significant."

Of those 190 schools, 171 (90%) had at least one homicide reported within the buffer zone at any time between 2005 and 2017. The average number of reported homicides within those zones during the study period was 8.8 homicides. One school, an elementary/middle school in Sandtown-Winchester/Harlem Park, had 33 homicides reported within the 1,000-foot buffer around it. Twenty-nine of those 33 homicides were firearm homicides. (**Map 4.9**)

Distance from Place of Residence

The 302 homicide victims whose home address block was known via the news-based database, and who were killed outside their place of residence and off their property, were killed an average of 1.95 miles away from their place of residence. The shortest distance was a few feet — where the victim was killed feet away from their place of residence but not within it or on their property. The longest distance was 10.9 miles. No statistically significant association between the distance from home and age, race, gender, or cause of death was found. The *MVDRS* data showed that 308 (11%) of victims between 2005 and 2015 were identified as residing outside of Baltimore City. Without more detailed information on those addresses, it was not possible to calculate the distances from their homes to the location of their victimization within Baltimore City.

Discussion

Homicides are not equally distributed in Baltimore City in terms of their locations. Between 2005 and 2017, homicides were concentrated in several CSAs in East and West Baltimore City, with a few more areas of concentration emerging as time went by. There was a difference in the location of hot spots between the pre-epidemic and the epidemic time period, as well. When taking into account the temporal characteristics of the homicides, some hot spots are

persistent across the study period while other hot spots appear and disappear. Other hot spots have only recently appeared, and other hot spots — like the one in Cherry Hill — has recently disappeared.

Comparing the two time periods (2005–2014 versus 2015–2017), CSAs showing an improvement (decrease) in the proportion of vacant housing were not those with lowest — or improving — homicide rates. For example, four CSAs in East Baltimore, including Oldtown/Middle East, are located directly where our spatial analysis showed persistent, sporadic, and diminishing hot spots. The same pattern applied for CSAs showing an improvement (decrease) in the proportion of households living under the poverty line. Places like Greater Mondawmin showed an increase of 4.1% in the proportion of households living under the poverty line between the two time periods, and it is one of the CSAs with the higher homicide rates throughout the study period. Yet there are other CSAs, like Cherry Hill or Greater Roland Park/Poplar Hill, where the proportion of households living under the poverty line increased between the two time periods, but there were no signs of emerging hot spots. This leads to the possibility that poverty and physical disorder alone are not the only drivers of the homicide rate. Or, alternatively, that there is some other community-level factor (e.g. the opioid epidemic) working together with poverty and physical disorder to drive the epidemic of homicides.

The finding of a vanished homicide hot spot in Cherry Hill corresponds with that CSA being the one with the highest decline in yearly homicide rate per 100,000 residents between the pre-epidemic and the epidemic time periods. Further research should be conducted on the environmental, social or individual characteristics of the residents and the victims to note any significant changes. Another form of research would also look at any interventions from

government or civil society in Cherry Hill to ascertain if any of those interventions are associated with the observed decline.

With this in mind, it is important to understand that hot spots do not necessarily answer the question of where the highest values are. Similarly, cold spots do not inform on where the lowest values are. This is because there could be an area of concentrated high values — homicide rates, in our analysis — with one or two low values in that same area. Or there could be a small area of high values within a larger area of low values. This is why it is necessary to understand the dynamics of the events we are examining beyond their spatial characteristics.

As with any analysis of data based on geographic information, the *Modifiable Areal Unit Problem* comes into play (Dark & Bram, 2007). While the *Baltimore Neighborhood Indicators Alliance* groups census tract data into the CSA data, the areas generated in doing this are somewhat subjective. Equally as subjective was the decision to outlaw the carrying of guns 1,000 feet from public schools. Those areas could have been easily aggregated into different areas, or the restriction around schools could have been 1,200 or 2,000 feet. This would cause some, but not all, of the inferences based on the location of the homicides to change. Just as is done with hot spot analysis, we, again, are reminded to be mindful of all the processes underlying the data we are using.

Another limitation in this analysis was the side of the road on which some of the homicides occurred. This is because we found that homicides whose location was reported in the media as the "x-hundred block of York Road" — or its extension, Greenmount Avenue — were geocoded to the west of that road. (Even address numbers are on the west side while odd address numbers are on the east.) That road serves as a boundary between several CSAs. As a result,

without knowing the exact location of the incident with full confidence, several homicides occurring on that road were geocoded to the CSA west of that road. So it is very possible that homicides belonging to Chinquapin Park/Belvedere or Greater Govans were instead linked to North Baltimore/Guilford/Homeland. Or homicides belonging in The Waverlies were instead linked to Greater Charles Village/Barclay.

These homicides did not constitute a sizeable proportion (≥ 10%) of homicides in those CSAs during the entire study period. Furthermore, our use of an average neighboring CSA homicide count helps deal with this problem to an extent. Nonetheless, detailed information on the exact location of the homicide down to which side of the street the incident happened would have helped to minimize this effect.

From the concentration curve and the negative binomial regression, we determined that homicides are concentrated in the poorest CSAs and that differences in poverty and physical disorder between CSAs are positively associated with the number of homicides those CSAs experienced. This aligns well with other research findings on the association of poverty, social disadvantage and homicides(Jones-Webb & Wall, 2008; William Alex Pridemore, 2002). It is important to note the existence of this association in Baltimore because poverty is also associated with other forms of violence, such as suicide (Kerr et al., 2017). Future research into poverty and suicide in Baltimore during this same time period may yield some interesting results as to whether or not all forms of violence resulting in death are on the increase since 2015, or if it is only homicides that have risen sharply.

In the analysis of homicides occurring near schools, it is important to note that the schools which saw the most homicides within 1,000 feet of their boundaries are also located within poor CSAs. As a result, it may be poverty or an associated neighborhood indicator which

is a predictor of the presence and the volume of homicides by any mechanism within that 1,000-foot zone. This is also a topic that would benefit from further research in order to better understand this kind of violence so close to such vulnerable populations.

While there was no association found between the distance from place of residence and any of the demographic variables and the cause of death, this is an area that requires further examination in a future study. We did not have available to us the specifics of each homicide, so there was no way to further stratify the homicides to, say, a drug deal, a robbery, or a purely random act. We could not infer if distance from a person's residence when they were killed was being influenced by other factors. We also did not have any information on homicide victims living outside of Baltimore and how they ended up being victimized in the city.

These analyses are not without limitations, some of which were mentioned above. The strict order not to match data from the news-based database with data in the *Maryland Violent Death Reporting System* did not allow for a multilevel analysis of homicides. If that analysis could have been done, we would have been able to combine location information, neighborhood indicator information, and individual social characteristics to better understand the interplay between these variables and how they explain the variance of shootings at a CSA level.

A final challenge in the interpretation of our findings arises in the necessary avoidance of the *ecological fallacy* or the *atomistic fallacy* in epidemiological research and its conclusions, where we must be careful not to assign the attributes of the CSA to the individual, or vice versa. It could very well be the case that it is not economically disadvantaged individuals being killed in the poorest CSAs, or that only the poor are being killed in the richest CSAs. Correspondingly, without home address information on all victims, we are making estimations on the CSA where

the incident happened, preventing us from making estimations on the victims based on the CSA where they lived.

Chapter 5: Review of Interventions to Prevent Homicide Victimization in Baltimore, Maryland

Introduction

Epidemics of infectious diseases usually end when one of three events occur. First, all of the susceptible individuals are infected, leaving no more possible hosts for the disease. Second, all individuals are immune to the disease, either because they already were infected and recovered — thus gaining immunity — or because they were somehow immunized without getting the disease. Third, the disease was so fast in going from infection to disease to recovery — or death — that it had no time to move on to a new set of susceptible hosts (Holme, 2013).

When it comes to the epidemic of homicides in Baltimore, these three scenarios may be applicable as well. First, everyone involved in behaviors or lifestyles that make them vulnerable to homicide victimization is killed, leaving no more "susceptible hosts." Or, second, an intervention or set of interventions stops violence from being transmitted within a network (e.g. a gang) or between networks. In this scenario, the third type of event would be a homicide that is truly random and does not trigger retaliation or other homicidal events.

In this section, we will focus on the second type of epidemic extinguishing event: An intervention of some sort that stops homicides from propagating by protecting individuals and groups at risk of homicide. We will classify these interventions into two categories. The first category are intervention programs coordinated primarily by the government, primarily the city government and including the police and health departments. The second category are intervention programs coordinated primarily by civil society, like citizen organizations or charity

groups. We will then conclude this section with a discussion of these interventions and how they fit into the findings of the previous two chapters. It must be noted that this review may not be exhaustive. There may be intervention programs that are not large enough to be documented, or they are embedded within other programs not aimed at violence, per se, but aimed at improvements in the socioeconomics of groups or individuals.

Methods

We conducted a grey literature review of programs aimed at reducing violence in general in Baltimore City existing in 2017. This included a search of news articles from *The Baltimore Sun* for mentions of programs or projects aimed at reducing violence in Baltimore. We also searched the official websites of the Baltimore Police Department (BPD),[16] the Baltimore City Health Department (BCHD),[17] the Baltimore City Public Schools (BCPS),[18] and the Baltimore Mayor's Office of Criminal Justice (MOCJ).[19]

For non-government-coordinated interventions, we conducted an online search for news articles from *The Baltimore Sun* and other local news service (e.g. radio or television) for mentions of violence-reduction programs. We then sought additional information from any of the programs mentioned through their online presence (website or online social networks).

[16] Baltimore Police Department official website: https://www.baltimorepolice.org/
[17] Baltimore City Health Department official website: https://health.baltimorecity.gov/
[18] Baltimore City Public Schools official website: http://www.baltimorecityschools.org/
[19] Baltimore Mayor's Office on Criminal Justice official website: https://mocj.baltimorecity.gov/

Results: Government-Coordinated Interventions

Mayor's Office Violence Reduction Plan

Mayor Catherine E. Pugh was elected in November of 2016 (Broadwater, 2016). During her campaign and since her inauguration, Mayor Pugh has spoken about violence in Baltimore City as a problem of the highest priority. To that end, she has implemented several violence reduction programs in the city and developed a comprehensive Violence Reduction Plan (Pugh, 2018). The plan includes goals of better policing, better access to city services by its residents, engagement with Baltimore youth, and expanding opportunities for advancement (Pugh, 2017).

As of April 2018, there are seven "Violence Reduction Zones" in Baltimore where "small, deeply troubled areas" of the city were "flooded" with a response from city government that included police and services. Employees from the Department of Public Works clean up those areas of things like trash on the street and alleyways. Housing inspectors survey the area for code violations. Local recreation centers extend their hours. Other services like needle exchanges and job information and training are also made available (Broadwa, 2018).

In the *Violence Reduction Update* of August 2017, the Office of the Mayor reports that recruitment into the police academy was 70% higher than at that time the previous year, that there was an increase in applicants who resided in Baltimore City, and that there was an increase in applicants who were African American. The report also notes initiatives with regards to community policing, improvement of training to officers on community relations and de-escalation skills to deal with mental health patients who are in crisis, and more oversight of the police department by the citizenry.

That same report also includes updates on efforts to reduce the number of opiate overdoses through the use of naloxone kits given out to the community. Other achievements, like community engagement to facilitate job acquisition, are also included in the report. The report concludes with a plan to create an Office of Sustainable Solutions that will use "data driven" approaches to identify and counteract problems within Baltimore that foster poverty and violence (Pugh, 2017).

Dating Matters and *Safe Streets*

Also within the city government, BCHD oversees two programs: Dating Matters and Safe Streets (Baltimore City Health Department, 2018b). Dating Matters is a grant-funded implementation of a program designed by the Centers for Disease Control and Prevention (CDC). According to CDC, Dating Matters is aimed at 11 to 14 year-olds in order to teach them strategies to recognize and prevent dating violence. Safe Streets is an adaptation of the Cure Violence model in Chicago, where violence is conceptualized as an infectious disease and the same approaches to disease prevention are instituted with at-risk individuals and groups as the intervention subjects.

Safe Streets consists of recruiting and training outreach workers from communities faced with increased levels of violence. Often, these outreach workers are themselves former convicts with ties to the community and experience in navigating the culture of the streets from those communities. The outreach workers identify conflict in the community and seek out the individuals involved in that conflict in order to mediate a non-violent solution to their dispute. Other work involves helping people at risk for violence perpetration with job searches, drug treatment and rehabilitation, or any other social services deemed necessary (Cure Violence, 2018). The program has operated in different areas around Baltimore, including Cherry Hill,

McElderry Park, Mondawmin, and Park Heights. An expansion of the program into Sandtown-Winchester began in 2016. For the 2018 fiscal year, the Maryland Legislature approved funding to expand the program to other places in Baltimore (Rector, 2017).

Baltimore Police Department Interventions

The Baltimore Police Department has several violence intervention programs in place or planned to deploy in 2018. One of the biggest programs is actually a group of different interventions under the umbrella term of *Community Policing*. In the report for calendar year 2016 on community policing results, BPD reported an increase in the number of recruits into the police force as well as an increase in the proportion of recruits who are from Baltimore and/or are African American. The report also emphasized the success in organizing events with the community. One such event was the community walk, where officers are encouraged to step out of their patrol vehicles, engage with the community, and walk around the neighborhoods. There was also mention of activities designed at engagement with youth to foster positive relationships between police officers and young people (K. Davis, 2017). The department is also seeking to bring back the *Officer Friendly* program (Miller, 2018). That program is designed at familiarizing youths and other people in the community with the work that police officers do to prevent crime and serve the public.

The department is also instituting a modern take on *Hot Spot Policing* that will use technology and intelligence to focus police patrols and involvement in places deemed to be hot spots. This program is to be modeled after similar programs in Los Angeles and Chicago, but different than previous programs that came under criticism by the US Department of Justice (Schuppe, 2018). Along with this program, the department is deploying *Mobile Metro Units* to focus intensely at areas with recent violent criminal activity (Anderson, 2018). These two

programs, *Hot Spot Policing* and *Mobile Metro Units*, are the descendants of the previous *Violent Crime Impact Section*, a program designed to send plainclothes officers into particularly violent sections of Baltimore. The program was successful in reducing violent crime and homicides (Webster, Buggs, & Crifasi, 2018). Despite its success, that program was disbanded when increased complaints of misbehavior and abuse by the officers were filed (Rector, 2018).

Expanded School Mental Health Program

The Baltimore City Public Schools System has put into place an *Expanded School Mental Health* program in collaboration with other city agencies and groups (Baltimore City Public Schools, 2018). The program is in place in "more than 100 schools." The program is described as being "similar to mental health clinics," offering a variety of mental health services to students and referrals to advanced mental health care if necessary. The program receives funding from the Department of Education and the Substance Abuse Mental Health Administration (Jablow, 2017). Recently, BCHD published an interactive map available to the public that identifies schools where this expanded mental health program is available.[20]

Results: Civil Society-Coordinated Interventions

Civil society is very much involved in violence prevention and reduction efforts in Baltimore City. Often, these organizations work hand-in-hand with city governmental institutions, or they receive funding from different government sources. Most are small or have very narrow scopes and goals. Others are well-known and based on models already at work in other places.

[20] The map of Baltimore City Public Schools where the expanded mental health programs are found can be accessed at http://bit.ly/bmorepsmentalhealth

Johns Hopkins Medicine *Summer Jobs Program*

Johns Hopkins Medicine has the Johns Hopkins Medicine *Summer Jobs Program* every summer in Baltimore (Johns Hopkins Medicine, 2018). The program is aimed at Baltimore City Schools students who have an interest in a career in the medical field. They are placed in an eight-week internship within a department in the institution. Part of the program also consists in professional development seminars in different topics.

University of Maryland Medical Center Violence Prevention Initiatives

The University of Maryland Medical Center (UMMC) has three violence prevention programs in place in Baltimore. The first is named the *Violence Intervention Project*, and it identifies patients within the medical center who are the victims of violence. The patients are then offered a wide variety of services in order to elicit a change in the patient's lifestyle that would prevent a subsequent episode of violent victimization (University of Maryland Medical Center, 2018b). The second program, *The Bridge Program*, focuses on patients who are victims of domestic violence. Like the *Violence Intervention Project*, this program uses different approaches to offer "assessment, crisis intervention, advocacy, education and counseling" along with community resources to also prevent subsequent domestic violence victimization (University of Maryland Medical Center, 2018a). A third program is aimed at partnering with schools and groups serving youths in Baltimore to educate them on paths into medical professions as well as to mentor them away from behaviors that place them at risk for victimization (University of Maryland Medical Center, 2018c)

Baltimore Ceasefire 365

Baltimore Ceasefire 365 is a community organization aimed at reducing gun violence through awareness campaigns and calls for "ceasefire weekends" (Baltimore Ceasefire 365, 2018). During those weekends, events are held around Baltimore to encourage a sense of community and to give a face and a name to the victims of gun violence. Other outreach work is also done by *Baltimore Ceasefire 365* volunteers, such as guiding people to city services they need or spreading information about drug treatment and rehabilitation.

Programs by Community Organizations

The American Friends Service Committee operates a mentoring program called *Friend of a Friend.* The program operates at correctional facilities alongside group therapy or group conversations. Participants are encouraged to discuss situations that lead to conflict and are then guided on conflict resolution and mediation (American Friends Service Committee, 2018).

The Family League of Baltimore sponsors a number of community partners to improve the lives of families in Baltimore (Family League of Baltimore, 2018). Among them are *Strong City Baltimore*, a program that operates different community and learning centers in Baltimore (Strong City Baltimore, 2018). The centers are aimed at improving the educational attainment of the participants as well as to improve the economic opportunities in the neighborhoods they serve.

There are also numerous neighborhood-specific organizations operating different programs in Baltimore. One of them is *Park Heights Renaissance*, a program led by residents of the Park Heights neighborhood in northwest Baltimore. The mission of the program is to implement plans for land, economic and human development (Park Heights Renaissance, 2015).

Another organization is the *East Baltimore Community Corporation*, an organization that operates several programs aimed also at community revitalization, increasing wealth and economic opportunity in the residents within its catchment area(East Baltimore Community Corporation, 2018a). Among those programs is also a drug treatment and rehabilitation center (East Baltimore Community Corporation, 2018b).

Discussion and Proposed Intervention Rating

In light of the current epidemic of homicides in Baltimore, it is difficult to ascertain whether any one program — or series of programs — are working to prevent or reduce violence. Different parties have different ideas of what works, as shown from the variety of intervention efforts recently put into place in Baltimore. Based on the findings from Chapter 4 of this dissertation, there is evidence that something worked in Cherry Hill to reduce the homicide rate between 2005 and 2017 and to eliminate the hot spot of homicides that existed there. Yet the only focused intervention in Cherry Hill we could find evidence for is *Safe Streets*, though there could have been increased police presence and police-community involvement. For example, in 2016, there was an arrest of 21 gang members operating in Cherry Hill as the *Hillside Enterprise*, with shootings and other crimes attributed to them ("Federal Indictment Charges 21 Defendants for Violent Drug Distribution Conspiracy Operating in the Cherry Hill Area of Baltimore," 2016).

Likewise, every discussion on the prevention of crime and victimization must focus on the root causes of these phenomena. What those root causes are is up for study and debate. For example, like other studies have found, a Cato Institute report concluded that increasing police presence or law enforcement resources in general was not associated with a reduction in crime.

Rather, it was the economic improvement of the country as a whole — and the areas within the country where improvement has been notable — that was associated with reduction in violent crime and property crime (Niskanen, 1994). This association with poverty and deprivation is best viewed in terms of relative poverty and relative deprivation. That is, the differences between the *haves* and the *have nots* are predictive of crime and victimization, since those who seek to acquire wealth but lack the opportunity to do so lawfully — while having plenty of opportunity to do so unlawfully — will commit crimes. This has been described by Chester and Wang (Chester, 1976; Wang & Arnold, 2008). The close proximity of wealth to poverty and the inability of those living in relative poverty to improve their situation leads to frictions that include violent crimes. More socially conservative opinions look to the "breakdown" of the traditional family as a cause of crime (Fagan, 1995).

Others have blamed a sort of *Ferguson Effect* at play in Baltimore after the death of Freddie Gray. The *Ferguson Effect* is a perception — based on opinion and some evidence — that police scaled back their operations after being under heavy scrutiny in the 2014 death of Michael Brown in Ferguson, Missouri (Gold, 2015). Similarly, the number of arrests in Baltimore City after the death of Freddie Gray and the ensuing riots decreased (Bier, 2016). Soon thereafter, the number of shootings and homicides began the epidemic trend that Baltimore is experiencing today. By mid-2016, the US Justice Department published a report of its findings from an investigation into BPD. The report was critical of police conduct toward the community and of unconstitutional behavior in its enforcement of the law (US Department of Justice, 2016). As a result, there is some evidence that police in Baltimore, like in Ferguson, were under scrutiny and may have scaled back their operations, altering the balance between guardians and motivated offenders that may have led to the current epidemic of violence.

Proposed Intervention Rating

In the United States as a whole, violent crime has been on the decline since the 1990s, yet there is evidence that violence is underreported. Sumner (Sumner et al., 2015) points out that there are more and more violence interventions being evaluated for their effectiveness, and early prevention of violence may be key since the risk of violence perpetration and/or victimization is dependent on the level of violence experienced by an individual at an early age. Based on the observations about the root causes of crime, the observed effects of police involvement and lack of involvement in the community, and the continuing expansion of knowledge of what works and what doesn't in violence prevention, we rated interventions in Baltimore according to several metrics.

First, we rated the intervention based on their location. If the intervention is centered on an area identified as an emerging hot spot, it was given one point.[21] If the intervention is aimed at a group at highest risk for victimization, it was given one point.[22] If the intervention is equitable, meaning that all benefit from the intervention and not just some groups of people, it was given one point. If there is evidence that the intervention is effective, it was given one point. If the intervention had been in place throughout the epidemic period (2015 to 2017), it was given one point. These points are then added up to give the intervention a preliminary rating. Table 5.1 shows the final ratings for the interventions identified. (**Table 5.1**) Of all the interventions in place in Baltimore, *Safe Streets* received the highest preliminary rating.

[21] An emerging hot spot is defined as a hot spot identified in chapter 4 as new, consecutive, intensifying, diminishing or oscillating. Figure 4.4 shows a graphic example and definitions of these hot spots.
[22] We identified these groups as African American men, ages 15 to 34, who were killed by firearm; and women of any age who were killed as a result of intimate partner violence or at their place of residence as a proxy for intimate partner violence.

The *Cure Violence* model used in Chicago and adapted as *Safe Streets* in Baltimore has been evaluated in different cities. In Chicago, an evaluation showed that the program was successful in reducing shootings, the intensity of gun violence hot spots, and had some success in preventing homicides from retaliation (Skogan, Hartnett, Bump, & Dubois, 2009). In New York City, the program was associated with a reduction in shootings in general and shootings due to interpersonal disputes in particular in the areas where it was put into place (Delgado et al., 2017). The model has also been used in San Pedro Sula, Honduras, one of the most violent cities in the world. The results there showed some effect in the reduction of shootings and homicides (Pedro, Ransford, Decker, Cruz, & Sánchez, 2017).

In Baltimore, *Safe Streets* had mixed results according to a report published in 2012 (Webster, Mendel Whitehill, Vernick, & Parker, 2012). In some neighborhoods, the number of shootings and homicides declined while the program was in place. In others, the number of shootings and homicides declined initially but then returned to previous levels. In others, there was no significant change. Since that report was issued, different mayoral administrations have touted the success of the program in the different Baltimore neighborhoods where it is active.

The existing programs at the University of Maryland Medical Center are interesting because the opportunities for secondary and tertiary prevention of violent victimization that they present. Carter found that youths who present to an emergency department in an urban setting for assault have increased risk of subsequent visits for violence victimization (Carter et al., 2015). Similarly, in a prospective cohort study, Cunningham et al found that patients who initially presented with injury from violence, and who had a substance use disorder and were female had higher odds of returning to the emergency department for care for assault within two years (Cunningham, Carter, & Ranney, 2015). The case-control study conducted specifically at the

University of Maryland Medical Center site showed findings similar to our findings in Chapter 3 in that most cases of firearm-related injuries were young African American men from the poorest parts of Baltimore (Shock, 2001). A similar retrospective cohort study in the state of Washington had similar observations to those made in Baltimore with respect to increased risk of firearm-related injuries that require hospitalization and increased risk of assault-related injuries, arrests for violence perpetration, and firearm-related death (Rowhani-Rahbar et al., 2015). With this in mind, a surveillance and follow-up system established at all of the city's emergency departments — as an expansion and adaptation of the program at the University of Maryland Medical Center — could aid in identifying those who are at risk for subsequent victimization beyond what systems outside the hospitals can do. It could possibly allow an intense intervention response to mitigate the risk factors that lead to that subsequent victimization.

The Johns Hopkins Medicine *Summer Jobs Program* has the capacity to impact the risk of victimization and perpetration of crime in adolescents in Baltimore. Similar programs in Chicago have been shown to be successful in reducing violent crime perpetration and other forms of risky behavior, though with some heterogenous effects based on the constitution of the participants (J. M. V Davis et al., 2017). It is not unreasonable to see a pathway where exposure to a plausible professional future leads youths to make better choices that place them at lesser risk of victimization and perpetration of violent crime. It is also not unreasonable to see such better professional opportunities leading to an improvement in socioeconomic status both at the individual level and at the neighborhood level where the participants live, further improving/reducing the violence situation.

The understanding that not all sociodemographic groups and not all areas of Baltimore are experiencing elevated levels of violence should guide the responses to the violence. This will

minimize inefficiencies by not prioritizing places and people who are not at increased risk of victimization. Other programs, the ones without an objective measure of effectiveness, should be evaluated objectively to better understand where they fit into the larger picture of violence in Baltimore and whether or not they should be modified.

Chapter 6: Conclusions and Recommendations

Introduction

Baltimore has been in the grips of an epidemic of homicides since April of 2015. The specific causes for this epidemic are varied. Nationwide, there has been an increase in homicides in urban areas, and these increases have been seen across social, racial and ethnic groups. Rosenfeld found that there was an increase nationally of about 8% in the homicide rate of whites between 2014 and 2015. Homicide rate in African Americans increased about 15% in that same time period (Rosenfeld, Spivak, & Muhlhausen, 2017). While there has been an increase in the total number of white victims in Baltimore, that increase has been proportional to previous years. White victims in Baltimore have been between 2.5% and 9% of all victims year after year during the study period, and 5.7% in 2014 to 5.3% in 2015.

While many of the societal problems identified in this dissertation have historical roots dating back decades or even centuries, other problems are more recent. Along with the epidemic of homicides in Baltimore, there is an epidemic of overdoses associated with the use and abuse of substances like heroin or prescription opioids (Baltimore City Health Department, 2018). This has brought an expansion of the illegal drug trade and, like it happened in the 1990s, an increase in violent acts. Yet there are unanswered questions on how much of the violence is directly related to the illicit drug trade, while there is some evidence that drug enforcement measures have an effect on homicide incidence (Webster et al., 2018).

In the third chapter of this dissertation, we were able to evaluate the differences in risk of homicide victimization in Baltimore between 2005 and 2017 depending on an individual's social and demographic information. We found that African American men ages 15 to 35 are

disproportionately represented in the victim data with homicide incidence rates several times higher than those of their white or Hispanic counterparts. We also found that most homicide victims had finished high school, but a substantial plurality of adult victims (38%) had not. Most victims were also reportedly employed.

In the fourth chapter of this dissertation, we analyzed the neighborhood-level characteristics of the locations where homicides occurred between 2005 and 2017. We found that homicides are clustered in space and time, but so are poverty and physical disorder. These latter two indicators were statistically significant in their association with the number of homicides in a given Community Statistical Area (CSA). Just like in the literature about homicide victimization in the rest of the United States, Baltimore seems to be no different when it comes to what predicts homicides more than any other indicator: Poverty.

While the City of Baltimore and non-governmental groups and organizations have mobilized to counter the epidemic of homicides and related violence occurring since 2015, their efforts seem to be concentrated on the younger segments of the population. This is perhaps in an attempt to prevent violence victimization or perpetration by educating youths on the perils of getting involved in certain behaviors which put them at risk of being victims or being criminals. When it comes to the adult segment of the population, there are a few programs aimed at diffusing feuds between groups and individuals which may escalate into violence. And, while there are job-training and job-placement assistance programs in Baltimore, they are not specifically aimed at preventing violence, though they may do so by improving the socioeconomic status of their participants.

There is also the question of gun control in Baltimore. Over 82% of the victims of homicide between 2005 and 2017 were killed by firearm. It is not an unreasonable assumption that the elimination of firearms in the hands of criminals and would-be criminals would have a substantial effect on the homicide rate in Baltimore. Yet Baltimore suffers from its geographic location when it comes to the movement of firearms between states with lax firearm acquisition laws and Maryland, a strict gun control state (Marton, 2016).

In this final chapter of this dissertation, we will give recommendations based on two categories: Person and Place. First, we will focus on the individual social characteristics that are malleable — such as education or employment — and on the characteristics that may help identify potential victims of homicide and reach them before they become a statistic. Next, we will focus on the neighborhood-level indicators and the patterns observed in our analysis in Chapter 4. How those patterns can be changed, and what other cities have done to change them will be discussed. Finally, we conclude the chapter with a discussion on the limitations of this research and on future steps that may be taken to overcome said limitations.

Recommendations Based on Individual Social Characteristics

African American men between the ages of 15 and 35 are at highest risk of homicide in Baltimore. Although they represent about 30% of the population, about 90% of homicide victims in Baltimore during the study period were African American men, with about 61% of all homicide victims being African American men between the ages of 15 and 35. This underscores the need for serious crime prevention and victimization prevention to be aimed at this segment of the population.

There is a "racial wealth divide" in Baltimore that is apparent when looking at the economic disparities between Baltimore's African American and white residents. While a neighborhood may change from poor to less poor or wealthy through gentrification, that same gentrification may have had the effect of moving out poor people of color from some neighborhoods and concentrating them in others, exacerbating the divide (Asante-Muhammad, 2017). There are also distinct differences in educational attainment between African American and white Baltimore residents, leading to different economic opportunities for them as adults.

Based on these findings, we recommend that neighborhood initiatives focused on changing the economic and social landscape take into account the impact on equity that those initiatives may have. For example, a plan to renovate a building and bring in businesses into it needs to ask, "Will this improve the economic profile of poor people in the neighborhood, or will it just drive them out of the neighborhood?"

The recent steps to "ban the box" in employment applications so as to reduce the discrimination in hiring practices based on criminal background is also a good star (Baltimore City Office of Civil Rights, 2018). This initiative, together with the *Violence Reduction Zones* program where job placement assistance is given along with improvements to neighborhoods in *hot zones* of violence should help expand the economic opportunities of young African American men in Baltimore.

While men have the higher incidence rate of homicide, women have the higher incidence rate of homicide as the result of intimate partner violence. Women are killed by firearm at an almost equal proportion as they are killed by other mechanisms. They were also more likely to be killed at home than men. From this, we can recommend an expansion of intimate partner

violence education to go beyond the teenage years and to focus on men as well as women, and to take into consideration economic pressures that may lead to intimate partner violence.

Children and older adults were less likely to be killed away from home. They were also less likely to be killed by firearms. In these instances, the current Child Fatality Review program could be expanded to include a deeper study of homicides in the elderly, or in vulnerable populations over the age of 18 such as those with mental health disease or a developmental delay. Currently, the Child Fatality Review only looks at deaths in children ages 0 to 17 (Bmore for Healthy Babies, 2018). Taking on additional cases in the populations mentioned would likely mean more work, but it would also mean an expansion of a program that already yields results in the understanding of how and why deaths happen in a vulnerable population. It would also help close the information gap noted in the *Maryland Violent Death Reporting System* by Maryland Department of Health staff by encouraging the collection of all available information on violent deaths in order to review them (Smith et al., 2017).

Adults who were never married clearly constituted the majority of homicide victims during the study period. There were marked differences between males and females in this respect, with 76% of male victims and 57% of female victims being never married. Nevertheless, being married seems to be a protective factor against homicide victimization. Whether this is the case in Baltimore because married individuals are generally more financially stable, older, and lead a more structured life is a good area for future research. Likewise, future research should look into the structure and mechanisms of intimate partner violence in Baltimore. It should pay close attention at mediating factors such as poverty and lack of economic opportunity. And it should also look at issues of gender identity in Baltimore and how those are related to homicide victimization.

The University of Maryland Medical Centers *Violence Intervention Project* should be expanded to all emergency departments in the Baltimore Metropolitan Area. These programs should be coupled with intense and continuous intervention strategies that address all of the victims' risk factors. While there is some indication that the City of Baltimore is seeking to expand *Safe Streets* to allow outreach workers access to gun violence victims at hospitals, such an expansion should include other forms of violence as well, such as intimate partner violence or simple assaults (Hsu, 2016).

Recommendations Based on Place

Poverty seems to be the most influential variable with respect to homicide counts at the CSA level. Poverty influences the homicide count (see the negative binomial regression results in Chapter 4) and has a lot of other factors that are correlated (collinear) with it that are known to be associated with violence. As stated before, the economic improvement of a place needs to include that place's residents and not just move out the poor and replace them with the wealthy because that concentrates poverty in other parts of the city, leading to crime and other societal problems there. Economic improvement needs to be equitable and sustained.

The Baltimore Police Department may wish to expand on its existing community policing program and make every officer a citizen of Baltimore even if they don't reside in the city. That is, every officer needs to have a vested interest in the improvement of the city and not just see their shift on patrol as a way to collect a paycheck and then go home for the day. Interactions between the police and civilians needs to be timely, common and amicable. Timely in that police respond to calls for service as soon as possible and work toward improving those times. Common in that Baltimore residents can become familiar with who is protecting them to the

point where they can name a police officer or at the least recognize the officer(s). And amicable in that not every interaction needs to be during the investigation of a crime or for official business only. Interactions should include community events, family gatherings, clean-up campaigns around neighborhoods in need, and other such opportunities that allow a one-on-one conversation between officers and civilians. This is especially important in the areas where emerging hot spots of homicides and other violent crime are occurring.

While it *Safe Streets* should not be citywide, the program should be expanded beyond its current areas. As we found in our hot spot analysis, there are large swaths of emerging hot spots in Baltimore that are in need of programs like *Safe Streets* to stop and prevent homicides. However, such an expansion must be gradual and take into account the needs and opinions of the people living in those areas, like any good public health intervention should. Another expansion of the program should look into schools and teaching young men and women how to resolve conflicts without violence and how to avoid joining gangs or participating in gang activity.

The *Violence Reduction Zones* program instituted by Mayor Pugh is a good start to holistically addressing violence in Baltimore. The program addresses two of the main predictors of violence we found in this dissertation: Poverty and Physical Disorder. If the program could be made permanent in the neighborhoods that need it most, and mobile enough that it can be moved from diminishing hot spots to emerging ones, the impacts of the program may be maximized.

What Has Worked in Other Cities?

While there has been a national declining trend in violent crime, some cities, like Baltimore, have not experienced it. Other cities have. In New York City, the most recent violent crime and homicide numbers are seen as record lows, with per capita rates not seen for more than

half a century (Southall, 2017). Economic improvement and better police practices are credited for the improvements seen in New York City.

In Oakland, California, efforts to reduce crime have been multifaceted. At the beginning of the century, neighborhood crime prevention councils were organized to keep an eye on crime and report to the city government any issues that the neighborhood residents see as contributing to crime. Data on crime locations and crime trends are shared periodically with the public and with all city agencies in an attempt to keep everyone involved and up-to-date on progress being made. Police officers continue their education on legal matters and professionalism as well. Finally, parolees from the state prison system are carefully monitored to prevent recidivism, and they are given tools to gain meaningful employment, education, and access to city services (Brown, 2000) More recently, the strategy has involved identification of individuals at highest risk of being perpetrators of violence crime, coming into contact with them, and offering them services to prevent them from committing crimes (Muhammad, 2018).

Shootings and homicides in Chicago have been on the decline for several months. The police department there has been using technology to help predict where the next shooting is most likely to happen based on the most recent trends. With that information in hand, police deploy additional patrols to areas at high risk (Alderden et al., 2012). There is also the effect of summer job programs for at-risk youth. Participants in summer jobs programs were less likely to be arrested for violent crimes, and that effect seemed to continue even after the program was over (J. M. V Davis et al., 2017). Another project, titled *Project Safe Neighborhoods*, used different tactics to improve policing practices and increase prosecutions of gun-related crimes, along with increased severity of sanctions for committing those crimes (Grunwald & Papachristos, 2017). Moreover, Chicago was also the city where the *Cure Violence* model

developed, and it has been at work since the beginning of the century. Its work has been closely linked to increases and decreases in violent crime at the locations where it has been operational (Ransford, Johnson, Decker, & August, 2000).

Stakeholder Buy-In

It must be emphasized that all of these interventions will be for naught without stakeholder buy-in. For this we must answer the question of who the stakeholders are when it comes to homicides in Baltimore. One could argue that all of Baltimore's residents are stakeholders because violence in general and homicides in particular affect the entire city in many ways, directly and indirectly reaching every resident in every neighborhood. However, the perception of being a stakeholder might be limited to only those residents living in the most violent neighborhoods in Baltimore, or those residents who have to deal with direct and tangible repercussions of homicide on a routine basis.

It would make no sense to dedicate a program to prevent homicides in African American young men if those young men do not feel at risk of victimization or are in distrust of the institutions and organizations performing the intervention. Also, an intervention whose main champion(s) is/are not a member(s) of the targeted population is also likely to have less effect than one where the population can relate to those spearheading the intervention. Based on these opinions and observations, we recommend that any strategy henceforth planned includes a careful analysis of who are the stakeholders, how they will be reached, and who will be the public face and/or leader of the intervention.

Limitations

There is always the possibility that a homicide can be misclassified as such when it was instead the result of some other manner of death. For example, a suicide may be classified as a homicide is not enough evidence at the scene or on the body supports the theory of a suicide. The opposite might also be the case, where a homicide is classified as a suicide, or even an accidental or non-violent death. The probability of this is minimal, as there are several levels of investigators involved in the assignment of a manner of death. From the police, to — if the victim survived to come into contact with healthcare — the healthcare providers who cared for the victim, to the medical examiner, there must be enough evidence and some consensus on the manner of death. Likewise, there is probably enough consensus on the cause of death as well.

We used the location of the homicide event instead of the victims' home addresses as the latter were not made available through the *Maryland Violent Death Reporting System*. This could cause some bias in the understanding of the interplay between the individuals and their neighborhoods as we may not be locating victims within their home CSA. As a result, while a CSA may have a higher homicide rate because of the events happening within it, another completely different CSA, or areas, may have a higher death rate because the victims originated from there. We attempted to answer this question using the home address information included in the news-based database, but the reliability of that information is questionable as it is based on unvalidated sources. Unlike the location of a homicide, which is well-known because of the magnitude and impact of such an event, the home address of a victim may not be fully confirmed by news reports of media briefings from law enforcement. For those reasons, it would have been preferable to use the information available in the *Maryland Violent Death Reporting System*, which includes several verification methods of this information. Based on this, we caution

against making inferences about the individuals based on where they were victimized, just like we would caution against making inferences about the locations where homicides happen based on the individuals victimized there.

With regard to the CSA information, the *Baltimore Neighborhood Indicators Alliance* did not have indicator data dating back to 2005. While most data could be extracted from US Census data, it would be difficult to reconcile those data with more recent data because of the changes in the size, shape and constitution of CSAs. A more detailed analysis of the data at the census block level instead of the CSA level would be possible, but this would further exacerbate the problems brought upon by the Modifiable Areal Unit Problem (Manley, 2014). Future studies would benefit from more years of *Baltimore Neighborhood Indicators Alliance* analysis on CSA data as those additional data would help identify secular trends versus true deviations from the norm.

We were also unable to fully address *Victim Precipitation Theory* in this study as no data were obtained with regards to the specifics of the homicide events, what caused them, what led up to them, or how the victim and the perpetrator were related. Future studies should conduct deep, detailed investigation of the precipitating factors for the homicide event. Knowing what precipitated homicide events can lead to better interventions where the actions or behaviors that led to those events can be modified or prevented. Of course, the information going into these studies should be based on solid epidemiological (public health) surveillance of violence, using many of the same methods used to understand and keep track of other health indicators and events of public health interest.

Conclusion

It is impossible to know every detail of such a complicated system as a diverse American city with 55 Community Statistical Areas, hundreds of neighborhoods, hundreds of thousands of people, tens of thousands of families, an unknown number of gangs, etcetera. Each group and subgroup within Baltimore has its own dynamics, so the interactions between strangers and acquaintances that end in homicide are so varied as to be almost impossible to categorize. For these reasons, population-based studies of homicide will miss the granular details of every interaction that resulted in a homicide. For example, would a drug transaction have ended in violence if the two parties had agreed on a proper exchange of money, or if it had occurred just a few meters closer to a police camera, or at a certain time of day? Likewise, studies focusing on the individuals — victims and/or perpetrators — may miss the larger forces at play at all the levels above the individual, e.g. group dynamics, institutionalized racism, or de facto segregation. This must all be taken into account when analyzing homicides in the future so as to find and report results in a meaningful way that informs as much as possible the interventions that may arise or the forecasts that are made. It is the sincere hope of the author that the information provided in this dissertation moves Baltimore even a fraction of a distance closer to a lasting state of peace, security and prosperity.

Tables

Table 3.1

	Year	Homicides No.	Homicide Rate per 100,000 Residents	Avg. Homicides	Avg. Homicide Rate per 100,000 Residents
Non-Epidemic	2005	269	42	238	38
	2006	276	43		
	2007	282	44		
	2008	234	37		
	2009	238	37		
	2010	223	36		
	2011	196	32		
	2012	218	35		
	2013	233	37		
	2014	211	34		
Epidemic	2015	342	55	334	54
	2016	318	51		
	2017	343	56		

Table 3.1 - Comparison of homicide counts and rates (per 100,000 residents) by year from 2005 to 2017 in Baltimore City and between the epidemic and non-epidemic homicide periods identified.

Table 3.2

	Homicide No. (Pct.)	*Mean Age (95% CI)*
All	3,366 (100)	30.5 (30.1–30.9)
Gender		
Male	3,059 (91)	30.2 (29.8–30.6)
Female	307 (9)	33 (31–35)
Race/Ethnicity		
African American	3,100 (92)	30 (29.5–30.4)
White	188 (6)	39.2 (36.9–41.6)
Hispanic	57 (2)	29.3 (26.1–32.5)
Race/Ethnicity and Gender		
African American Men	2,861 (85)	29.7 (29.3–30.1)
White Men	132 (4)	40.4 (37.6–43.2)
Hispanic Men	50 (1)	30.3 (27–33.7)
African American Women	239 (7)	32.8 (30.4–35.1)
White Women	56 (2)	36.5 (32.2–40.7)
Hispanic Women	7 (<1)	21.7 (12.7–30.7)

Table 3.2 - Mean age and 95% confidence intervals for victims reported in the news-based database between 2005 and 2017 by gender, race/ethnicity, and gender/race/ethnicity.

Table 3.3

	Homicides, no. (%), N=3,366	Crude Incidence per 100,000 (95% CI)	Age-Adjusted Incidence per 100,000* (95% CI)	Age-Adjusted Incidence Rate Ratio (95% CI)	Age-Adjusted Incidence Rate Difference (95% CI)
Gender					
Female	307 (9.1)	92 (82–103)	89 (79–99)	1	1
Male	3,059 (90.9)	1,042 (1,006–1,080)	977 (942–1011)	11 (10–12)	887 (849–926)
Race/Ethnicity					
White	188 (5.6)	108 (93–125)	102 (87–117)	1	1
Hispanic	57 (1.7)	220 (166–285)	190 (141–239)	2 (1–3)	88 (29–147)
African American	3,100 (92.1)	783 (756–811)	812 (783–841)	8 (7–9)	710 (678–742)
Age Group		**Incidence per 100,000 (95% CI)**		**Incidence Rate Ratio (95% CI)**	**Incidence Rate Difference (95% CI)**
0-14	79 (2)	68 (53–82)		1	1
15-24	1,159 (34)	1,250 (1,178–1,322)		19 (15–23)	1183 (1109–1256)
25-34	1,145 (34)	1,095 (1,032–1,159)		16 (13–20)	1028 (962–1093)
35-44	538 (16)	681 (623–738)		10 (8–13)	613 (554–673)
45-64	379 (11)	241 (217–266)		4 (3–5)	174 (145–202)
65+	66 (2)	87 (66–108)		1 (1–2)	20 (-6–45)

*Table 3.3 - Age-adjusted homicide rates, rate ratios, and rate differences by demographic group reported to the news-based database between 2005 and 2017. Age-adjusted homicide rates, rate ratios, and rate differences by demographic group reported to the news-based database between 2005 and 2017. *Using 2010 US Census Population.*

Table 3.4

	Total Homicides, No. (Group Pct.)	*Male Homicides, No. (Group Pct.)*	*Female Homicides, No. (Group Pct.)*	*African American Homicides, No. (Group Pct.)*	*White Homicides, No. (Group Pct.)*	*Hispanic Homicides, No. (Group Pct.)*
Education Level						
Child, Some Education	185 (9)	151 (8)	34 (19)	167 (9)	15 (15)	3 (9)
Adult, Some High School	769 (38)	726 (40)	43 (24)	695 (38)	37 (37)	22 (65)
GED/High School Only	956 (48)	866 (47)	90 (50)	887 (49)	47 (47)	9 (26)
Some College	89 (4)	78 (4)	11 (6)	86 (5)	2 (2)	1 (3)
College Completed	13 (1)	11 (1)	2 (1)	10 (1)	2 (2)	0 (0)
Gang Related						
Not Gang Related	1,942 (72)	1,730 (71)	212 (82)	1,746 (71)	122 (81)	0 (0)
Gang Related	34 (1)	33 (1)	1 (<1)	34 (1)	0 (0)	32 (80)
Unknown	707 (27)	662 (27)	45 (17)	667 (27)	29 (19)	8 (20)
Substances Found						
No Substances Found	349 (37)	318 (37)	31 (37)	337 (38)	8 (17)	2 (20)
Alcohol Only	126 (13)	118 (14)	8 (10)	116 (13)	4 (8)	4 (40)
Alcohol and Other Substances	131 (14)	122 (14)	9 (11)	116 (13)	12 (25)	2 (20)
Substances Other Than Alcohol Only	338 (36)	303 (35)	35 (42)	310 (35)	24 (50)	2 (20)
Employment						
Employed	1,813 (68)	1,648 (68)	165 (64)	1,631 (67)	112 (74)	34 (85)
Not Employed	337 (13)	309 (13)	28 (11)	323 (13)	10 (7)	0 (0)
Student	272 (10)	245 (10)	27 (10)	259 (11)	8 (5)	3 (8)
Child, Not Employed	54 (2)	37 (2)	17 (7)	46 (2)	8 (5)	0 (0)
Disabled	44 (2)	38 (2)	6 (2)	38 (2)	5 (3)	0 (0)
Child, Employed	11 (0)	8 (0)	3 (1)	9 (0)	2 (1)	0 (0)
Unknown	142 (5)	130 (5)	12 (5)	131 (5)	6 (4)	0 (0)

Missing	10 (<1)	10 (<1)	0 (0)	10 (<1)	0 (0)	3 (8)
Homicide Location						
Home	373 (14)	250 (10)	123 (48)	318 (13)	41 (27)	5 (13)
Away from Home	2,283 (85)	2,152 (89)	131 (51)	2,105 (86)	108 (72)	34 (85)
Unknown	27 (1)	23 (1)	4 (2)	24 (1)	2 (1)	1 (3)
Marital Status						
Married Adult	268 (10)	227 (9)	41 (16)	226 (9)	21 (14)	12 (30)
Never Married Adult	1,983 (74)	1,836 (76)	147 (57)	1,858 (76)	72 (48)	23 (58)
Other non-Married Adult	175 (9)	145 (6)	30 (12)	130 (5)	39 (26)	1 (3)
Children, Not Married	184 (7)	150 (6)	34 (13)	166 (7)	15 (10)	3 (8)
Unknown	73 (3)	67 (3)	6 (2)	67 (3)	4 (3)	1 (3)
Intimate Partner Violence						
Intimate Partner Violence	85 (3)	27 (1)	58 (22)	71 (3)	10 (7)	3 (8)
Not Intimate Partner Violence	2,542 (95)	2,346 (97)	196 (76)	2,323 (95)	138 (91)	37 (93)
Unknown	56 (2)	52 (2)	4 (2)	53 (2)	3 (2)	0 (0)
Homelessness						
Homeless	22 (1)	19 (1)	3 (1)	17 (1)	4 (3)	0 (0)
Not Homeless	2,577 (96)	2,328 (96)	249 (97)	2,361 (96)	141 (93)	35 (88)
Missing	84 (3)	78 (3)	6 (2)	69 (3)	6 (4)	5 (12)

Table 3.4 - Summary of the individual social characteristics of victims, by gender and race/ethnicity, reported to the Maryland Violent Death Reporting System.

Table 3.5

	Homicides, no. N=3,366	*Firearm No. (Row %)*	*Stabbing No. (Row %)*	*Other No. (Row %)*
Gender				
Male	3,059	2622 (86)	253 (8)	184 (6)
Female	307	157 (51)	58 (19)	92 (30)
Race/Ethnicity				
African American	3,100	2637 (85)	259 (8)	204 (7)
White	188	98 (52)	36 (19)	54 (29)
Hispanic	57	34 (60)	11 (19)	12 (21)
Age Group				
0-14	79	20 (25)	3 (4)	56 (71)
15-24	1,159	1049 (91)	88 (8)	22 (2)
25-34	1,145	1029 (90)	79 (7)	37 (3)
35-44	538	430 (80)	54 (10)	54 (10)
45-64	379	232 (61)	69 (18)	78 (21)
65+	66	19 (29)	18 (27)	29 (44)

Table 3.5 - Distribution of cause of death (Firearm, Stabbing, Other) by gender, race/ethnicity and age group reported in the news-based database between 2005 and 2017.

Table 3.6

	Homicides n=2,683	*Firearm No. (Row %)*	*Stabbing No. (Row %)*	*Other No. (Row %)*
Education				
No High School	954	781 (82)	98 (10)	75 (8)
High School or Higher	1,058	874 (83)	123 (12)	61 (6)
Unknown	671	531 (79)	75 (11)	65 (10)
Marital Status*				
Married/Civil Union	268	209 (78)	28 (10)	31 (12)
Never Married	1,983	1692 (85)	199 (10)	92 (5)
*Other/Not Married**	247	165 (67)	45 (18)	37 (15)
Presence of Alcohol and Other Substances				
No Substances Found	349	309 (89)	24 (7)	16 (5)
Alcohol Only	126	93 (74)	29 (23)	4 (3)
Alcohol and Other Substances	131	101 (77)	25 (19)	5 (4)
Substances Other Than Alcohol	338	285 (84)	24 (7)	29 (9)
Employment				
Employed	337	296 (88)	23 (7)	18 (5)
Not Employed	1,813	1471 (81)	219 (12)	123 (7)
Student	272	235 (86)	30 (11)	7 (3)
Child, Not Employed	54	13 (24)	4 (7)	37 (69)
Child, Employed	11	8 (73)	3 (27)	0 (0)
Disabled	44	30 (68)	7 (16)	7 (16)
Unknown	142	124 (87)	10 (7)	8 (6)
Injured at Home				
Home	373	202 (54)	91 (24)	80 (21)
Away From Home	2,283	1967 (86)	202 (9)	114 (5)
Unknown	27	17 (63)	3 (11)	7 (26)
Intimate Partner Violence				
Yes	85	32 (38)	38 (45)	15 (18)
No	2,542	2101 (83)	257 (10)	184 (7)
Unknown	55	53 (96)	1 (2)	1 (2)
Homelessness				
Homeless	22	9 (41)	7 (32)	6 (27)
Not Homeless	2,577	2110 (82)	278 (11)	189 (7)
Unknown	84	67 (80)	11 (13)	6 (7)
Gang Involvement				
Gang-Involved	34	30 (88)	4 (12)	0 (0)

Not Gang-Involved	1,942	1540 (79)	224 (12)	178 (9)
Unknown if Gang-Involved	707	616 (87)	68 (10)	23 (3)

*Table 3.6 - Distribution of cause of death (Firearm, Stabbing, Other) by different individual social characteristics reported in the Maryland Violent Death Reporting System between 2005 and 2015. * Does not include children under 18. ** Includes only victims from 2012 to 2015*

Table 3.7

	Firearm Homicide No. (Odds)	*Crude Odds Ratio (95% CI)*	*Adjusted[a] Odds Ratio (95% CI)*
Gender			
Female (n=258)	130 (1.02)	1.00	1.00
Male (n=2,425)	2,056 (5.57)	**5.49 (4.20–7.17)**	**4.65 (3.52–6.14)**
Race			
Non-African American (n=236)	131 (1.25)	1.00	1.00
African American (n=2,447)	2,055 (5.24)	**4.20 (3.18–5.55)**	**3.62 (2.69–4.85)**
Age			
Child (n=185)	120 (1.85)	1.00	1.00
Adult (n=2,498)	2,066 (4.78)	**2.59 (1.88–3.56)**	**2.38 (1.70–3.35)**
Education			
No High School (n=954)	781 (4.51)	1.00	1.00
At Least High School (n=1,058)	874 (4.75)	1.05 (0.84–1.32)	0.79 (0.61–1.04)
Marital Status			
Not Married/Never Married (n=2,158)	1,800 (5.03)	1.00	1.00
Married (n=268)	209 (3.54)	**0.70 (0.52–0.96)**	0.89 (0.64–1.23)
Presence of Alcohol			
No Alcohol Present (n=687)	594 (6.39)	1.00	1.00
Alcohol Present (n=257)	194 (3.08)	**0.48 (0.34–0.69)**	**0.38 (0.26–0.56)**
Employment			
Unemployed (n=859)	707 (4.65)	1.00	1.00
Employed (n=1,824)	1,479 (4.29)	0.92 (0.75–1.13)	**0.71 (0.55–0.92)**
Injured at Home			
Injured Away from Home (n=2,283)	1,967 (6.22)	1.00	1.00
Injured at Home (n=373)	202 (1.18)	**0.19 (0.15–0.24)**	**0.26 (0.20–0.34)**
Intimate Partner Violence			
Not Intimate Partner Violence (n=2,542)	2,101 (4.76)	1.00	1.00
Intimate Partner Violence (n=85)	32 (0.60)	**0.13 (0.08–0.20)**	**0.24 (0.14–0.40)**
Homelessness			
Not Homeless (n=2,661)	2,177 (4.98)	1.00	1.00
Homeless (n=22)	9 (0.69)	**0.15 (0.07–0.36)**	**0.14 (0.06–0.36)**
Gang Involvement			
Not Gang-Involved (n=1,942)	1,540 (3.83)	1.00	1.00
Gang-Involved (n=34)	30 (7.50)	1.96 (0.67–5.59)	1.51 (0.51–4.48)

Table 3.7 - Number of homicides by firearm along with crude and adjusted odds ratios, stratified by individual social characteristics. [a]Adjusted for Gender, Race and Age >=18

Table 3.8

	Pre-Epidemic Homicides No. (%)	*Post-Epidemic Homicides No. (%)*	*Whole Time Period No. (%)*
Gender			
Female	233 (10)	74 (7)	307 (9)
Male	2136 (90)	923 (93)	3059 (91)
Total	**2,369**	**997**	**3,366**
Race/Ethnicity			
White	128 (5)	60 (6)	188 (6)
African American	2179 (92)	921 (92)	3100 (93)
Hispanic	48 (2)	9 (1)	57 (2)
Total	**2,369**	**997**	**3,345**
Age Group			
0-14	55 (2)	24 (2)	79 (2)
15-24	857 (36)	302 (30)	1159 (34)
25-34	775 (33)	370 (37)	1145 (34)
44-64	631 (27)	286 (29)	917 (27)
≥65	51 (2)	15 (2)	66 (2)
Total	**2,369**	**997**	**3,366**
Cause of Death			
Firearm	1917 (81)	862 (86)	2779 (83)
Stabbing	242 (10)	69 (7)	311 (9)
Other	210 (9)	66 (7)	276 (8)
Total	**2,369**	**997**	**3,366**

Table 3.8 - Comparison of the proportion of homicides by different individual social characteristics between the pre-epidemic and the post-epidemic time periods.

Table 3.9

	Pre-Epidemic Odds	*Post-Epidemic Odds*	*Crude Odds Ratio (95% CI)*	*Adjusted [a] Odds Ratio (95% CI)*
Gender				
Male	9.17	12.47	**1.36 (1.04–1.79)**	1.20 (0.90–1.59)
Race				
African American	11.47	12.12	1.06 (0.80–1.40)	0.92 (0.69–1.22)
Age				
≥18	12.94	18.94	**1.46 (1.06–2.03)**	1.34 (0.97–1.86)
Firearm Homicide				
Yes	4.24	6.39	**1.51 (1.22–1.85)**	**1.44 (1.16–1.80)**

Table 3.9 - Crude and adjusted odds ratio of pre-epidemic and epidemic homicides by firearm. [a] Adjusted by all other covariates.

Table 4.1

	% of Households Below Poverty	***% of Vacant Households***	***% High School Completion***	***Median Household Income***	***Population Density***	***Racial Diversity Index***	***Physical Disorder***
% of Households Below Poverty	1	0.72	-0.53	-0.78	0.33	-0.26	0.70
% of Vacant Households	0.72	1	-0.39	-0.60	0.44	-0.46	0.77
% High School Completion	-0.53	-0.39	1	0.34	-0.44	-0.01	-0.53
Median Household Income	-0.78	-0.60	0.34	1	-0.18	0.27	-0.65
Population Density	0.33	0.44	-0.44	-0.18	1	-0.15	0.50
Racial Diversity Index	-0.26	-0.46	-0.01	0.27	-0.15	1	-0.33
Physical Disorder	0.70	0.77	-0.53	-0.65	0.50	-0.33	1

Table 0-5. Pearson correlation coefficients for Community Statistical Area-level variables.

Table 4.2

Community Statistical Area Indicator	*Unadjusted Incidence Rate Ratio (95% CI)[a]*	*Adjusted Incidence Rate Ratio (95% CI)[b]*	*Final Model, Adjusted Incidence Rate Ratio (95%CI)[c]*
Percentage of Households Living Under the Poverty Line (10% Increments)	**1.73 (1.47–2.04**	**1.19 (1.01–1.41)**	**1.21 (1.04–1.40)**
Index of Physical Disorder	**1.64 (1.49–1.80)**	**1.47 (1.26–1.72)**	**1.47 (1.30–1.66)**
Average Number of Homicides in Neighboring CSAs (10 Homicide Increments)	**1.19 (1.11–1.27)**	1.04 (0.98–1.10)	1.05 (0.99–1.11)
Percentage of Residential Properties That Are Vacant and Abandoned (10% Increments)	**1.77 (1.50–2.10)**	1.08 (0.88–1.31)	--
High School Completion Rate (10% Increments)	**0.39 (0.24–0.63)**	1.10 (0.76–1.58)	--
Population Density (1,000 people per square mile increments)	**1.05 (1.01–1.09)**	0.98 (0.96–1.01)	--
Racial Diversity Index	**0.89 (0.82–0.96)**	0.98 (0.93–1.04)	--

Table 0-6. Results from negative binomial regression on homicide counts (rates) per Community Statistical Area (CSA) by CSA indicators. [a] Each row represents a univariate model. [b] Results represent a multivariable model. [c] Results from single, multivariable model with Percentage of Households Living Under the Poverty Line and Physical Disorder as independent variables.

Table 4.3

	2005-2017 Homicides		*2005-2017 Homicides Subset*	
	Hot Spots	Cold Spots	Hot Spots	Cold Spots
New	43	64	75	0
Consecutive	137	137	109	0
Intensifying	100	56	60	0
Persistent	482	320	202	0
Diminishing	19	0	48	0
Sporadic	616	481	404	0
Oscillating	3	0	0	0
Historical	1	0	0	0

Table 0-7. Number of hot spots and cold spots by type for the entire dataset (2005 to 2017 homicides) and subset (2005 to 2017 homicides of African American men ages 15 to 34 who were victims of firearm homicide).

Table 5.1

Intervention	*Active in an emerging hot spot?*	*Aimed at a risk group?*	*Equitable Application?*	*Effective?*	*Long Term?*	*Rating*
Safe Streets	Yes	Yes	Yes	Yes	Yes	5
Violence Reduction Zones	Yes	No	Yes	Unknown	No	2
Mobile Metro Units	Yes	Yes	No	Yes	No	3
Officer Friendly	Mixed	Mixed	Yes	Unknown	No	1+
Hot Spot Policing	Yes	Yes	No	Mixed	No	2+
Baltimore City Schools Mental Health Aid	Mixed	No	Yes	Mixed	Yes	2+
Dating Matters	Mixed	Yes	Yes	Yes	No	3+
UMMC Violence Intervention Project	Mixed	Yes	Yes	Yes	No	3+
UMMC The Bridge Program	Mixed	Yes	Yes	Mixed	No	2+
Baltimore Ceasefire	Mixed	Yes	Yes	Unknown	No	2
AFSC Friend of a Friend	No	Yes	Yes	Unknown	No	2
Strong City Baltimore	Yes	Mixed	Yes	Unknown	Yes	3+
Park Heights Renaissance	Yes	Mixed	Yes	Unknown	Yes	3+
East Baltimore Community Corporation	Yes	Mixed	Yes	Unknown	Yes	3+
Johns Hopkins Summer Jobs Program	No	Yes	Yes	Yes	Yes	4

Table 0-8. Proposed rating of selected violence intervention programs in Baltimore. One point was awarded for each "Yes." A plus sign (+) denotes that there is "mixed" evidence that the program is active in an emerging hot spot, aimed at a risk group, or effective. Risk groups were defined as African American males between the ages of 15 and 34, and women age 15 and above who may become victims of intimate partner violence. Effectiveness is measured via available literature of the program or similar programs having a reduction effect on violent crime victimization and/or perpetration. Long term denotes that the program has been active for more than one year up to and including 2017.

Figures

Figure 1.1

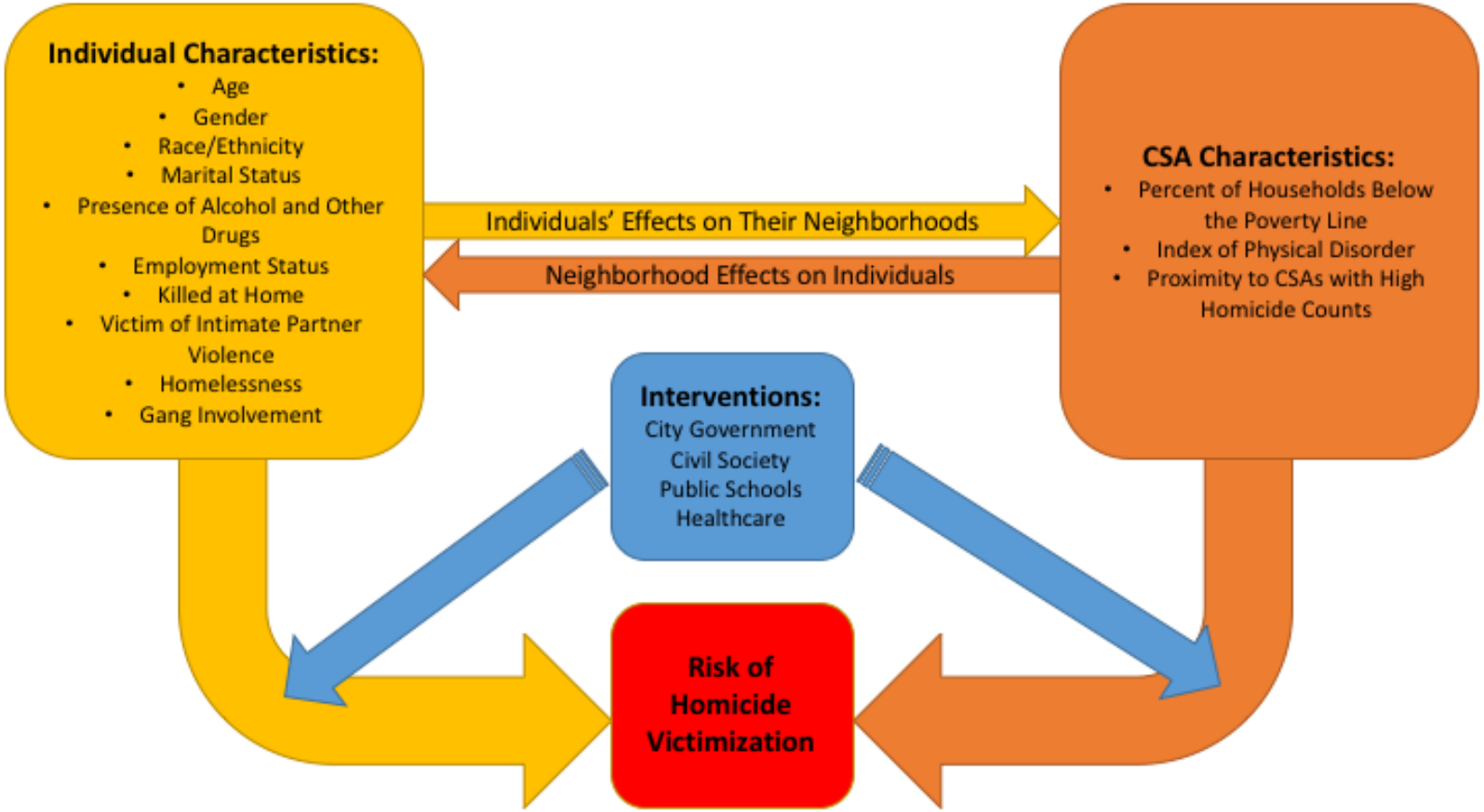


Figure 1.0.1 - Conceptual Framework showing the interplay between individuals and their neighborhood (Community Statistical Area, CSA) environments as well as the pathways that lead to a risk of homicide victimization. Interventions may be applied at the individual or CSA level to reduce or eliminate the risk of homicide victimization.

Figure 1.2

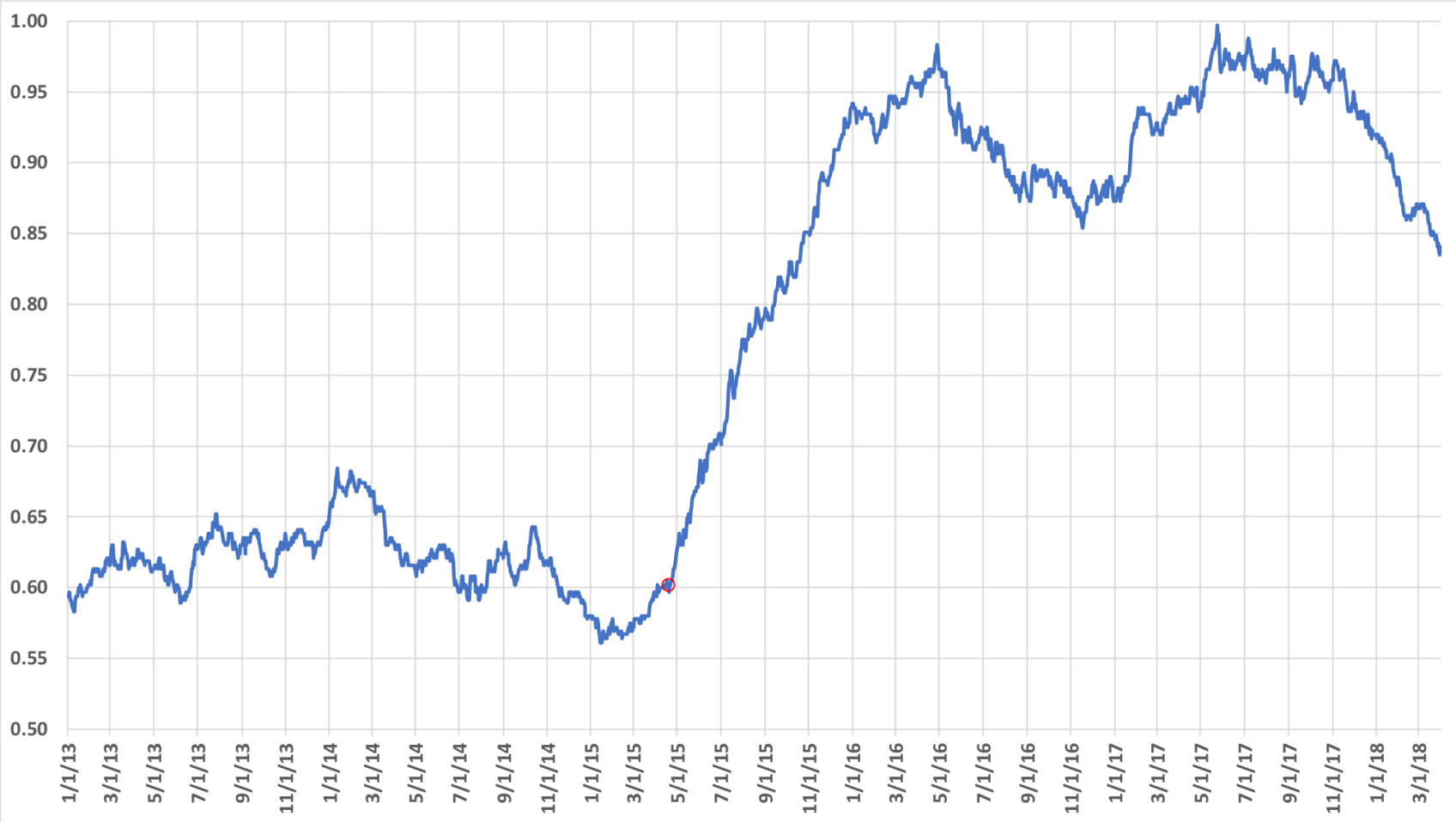


Figure 1.0.2 – Number of homicides per day in the previous 365 days in Baltimore City between July 1, 2005 and December 31, 2017. The red marker in April 2015 indicates the date of the 2015 riots.

Figure 3.1

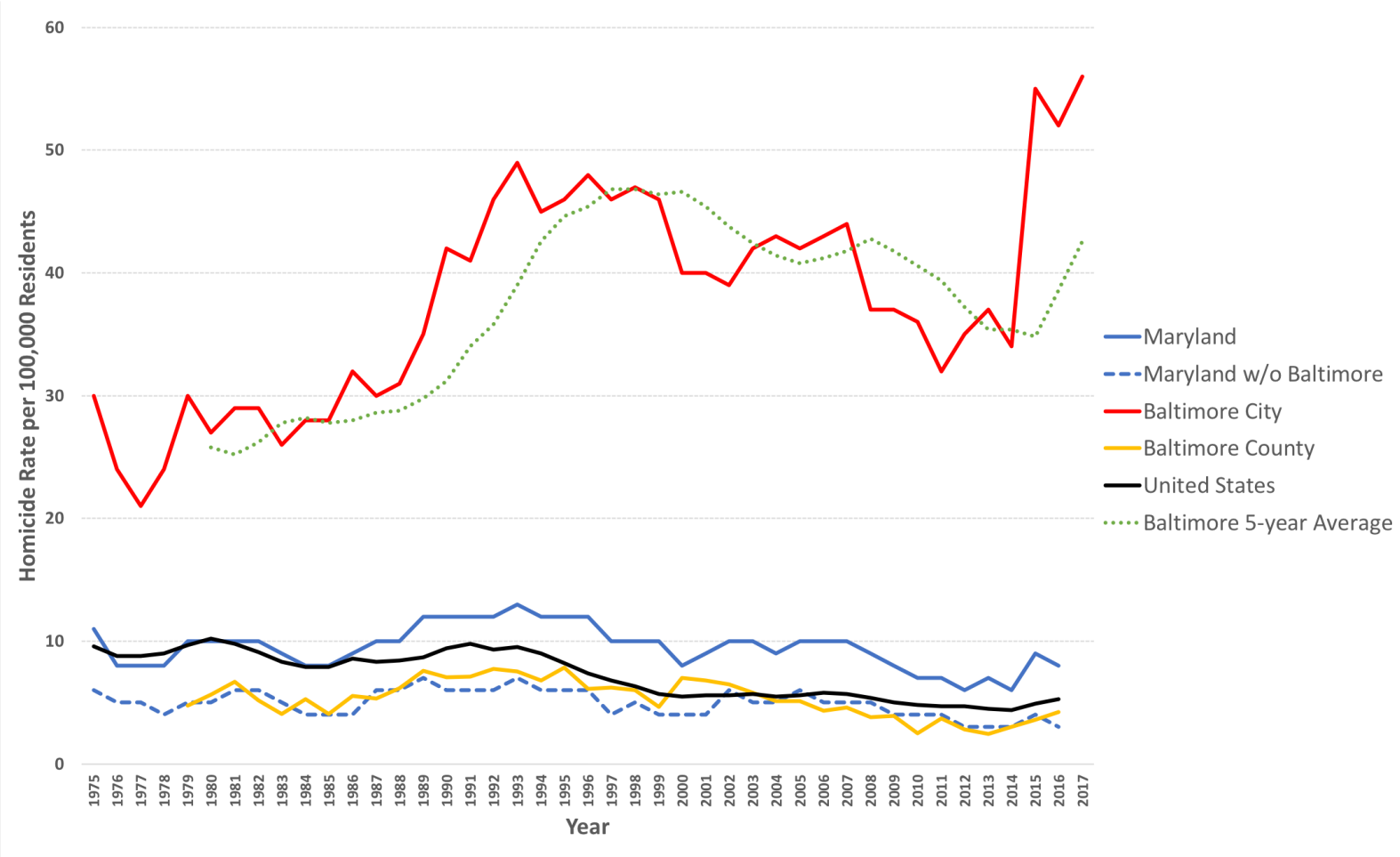


Figure 3.1 – Homicide rate per 100,000 residents for Baltimore City, Baltimore County, Maryland, Maryland without Baltimore City's homicide count, and the United States, 1975 to 2017. (Rates for jurisdictions other than Baltimore City in 2017 not available.)

Figure 3.2

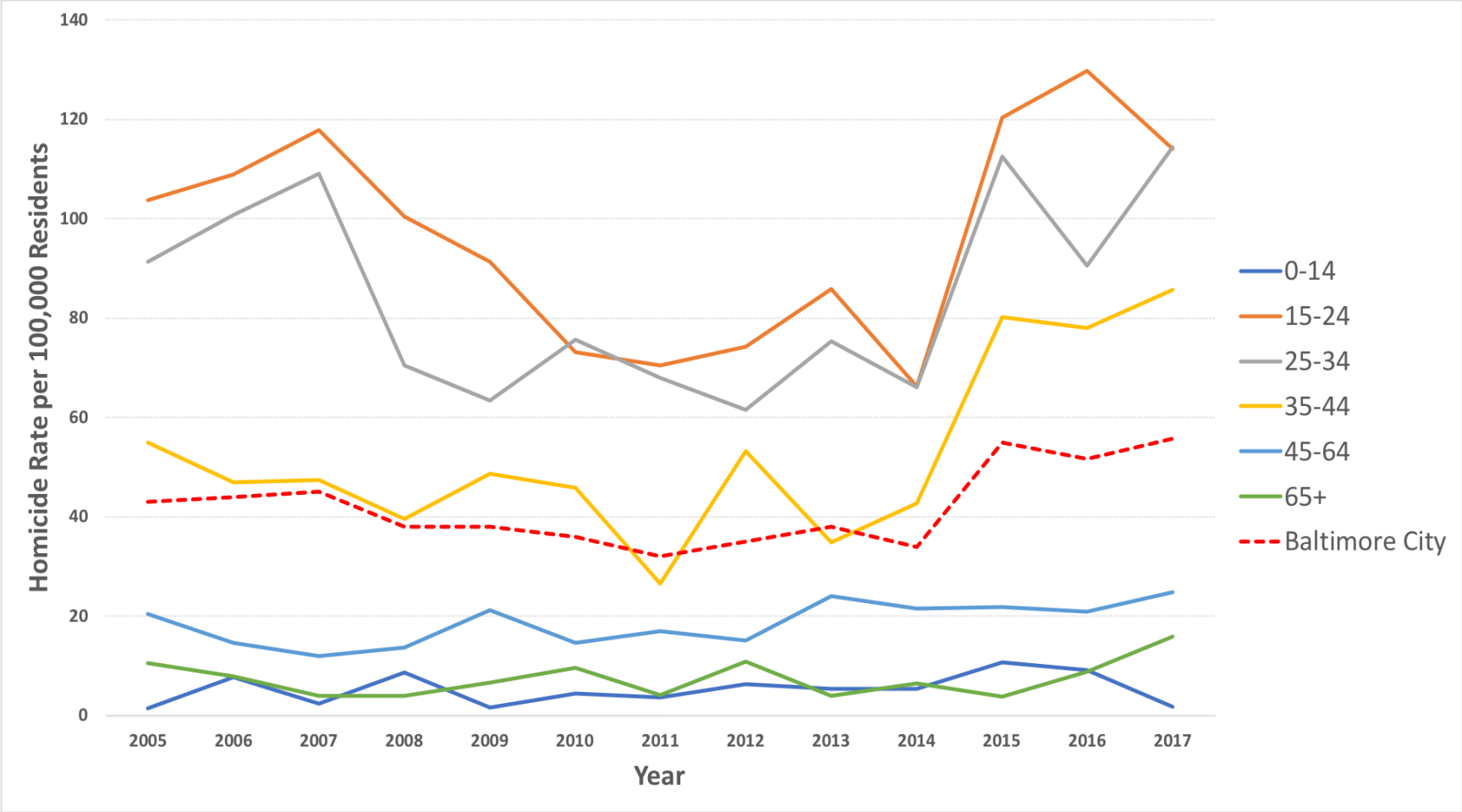


Figure 3.2 – Homicide rates per 100,000 residents by age group and year reported to the news-based database between 2005 and 2017.

Figure 3.3

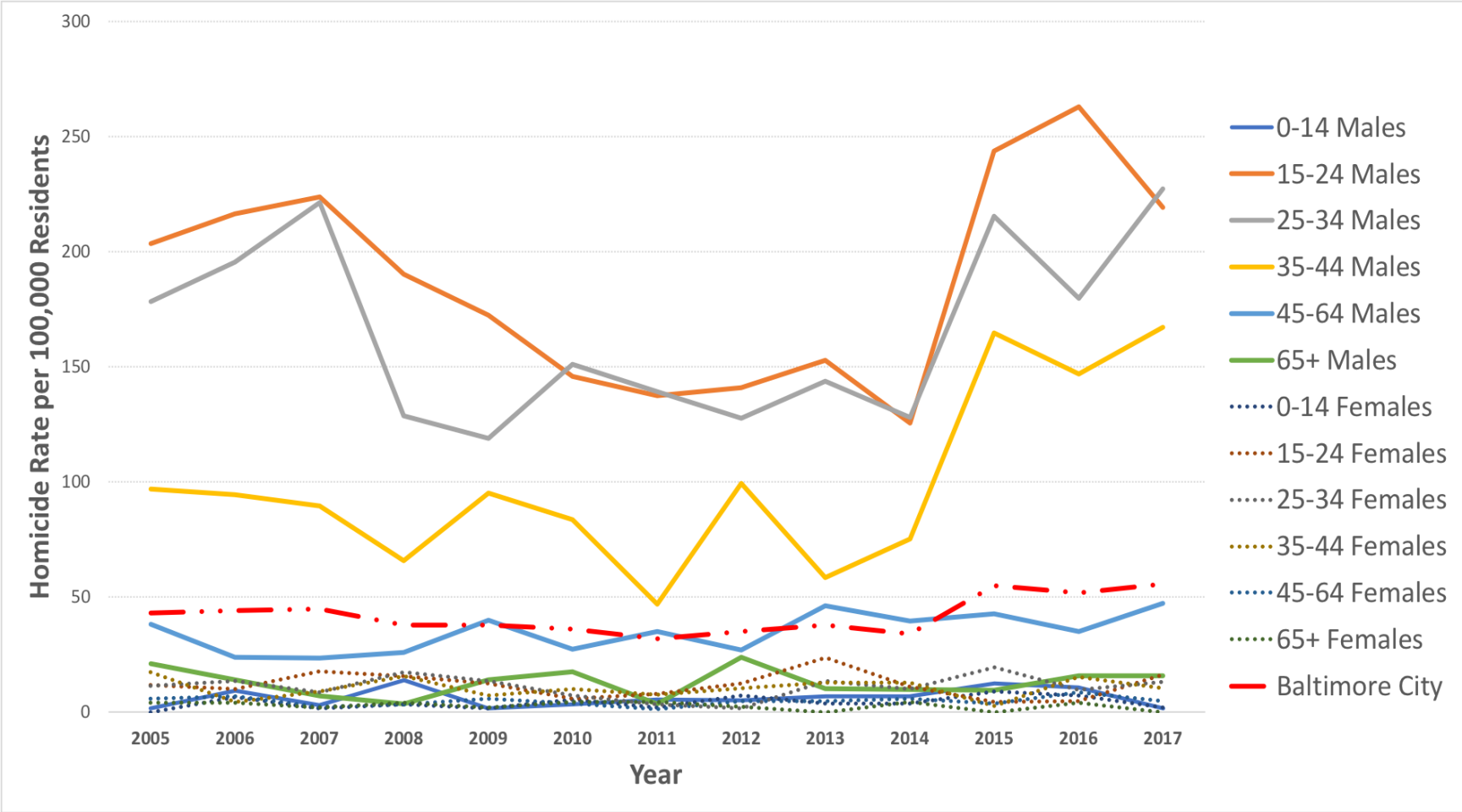


Figure 3.3 – Homicide rate per 100,000 residents by age group, gender, and year reported to the news-based database between 2005 and 2017.

Figure 3.4

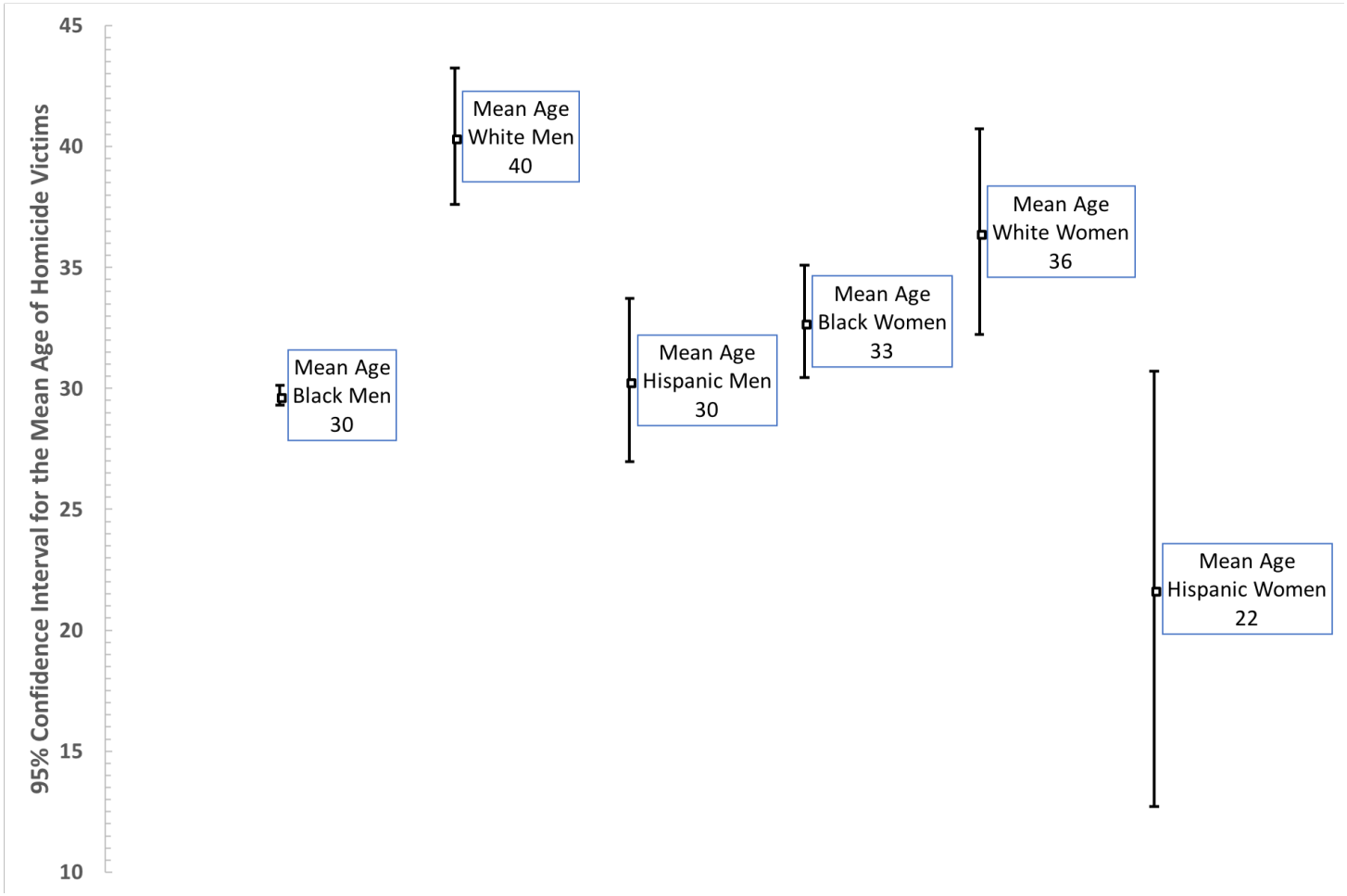


Figure 3.4 – Mean age and 95% confidence interval by homicide victim demographic group reported to the news-based database between 2005 and 2017.

Figure 3.5

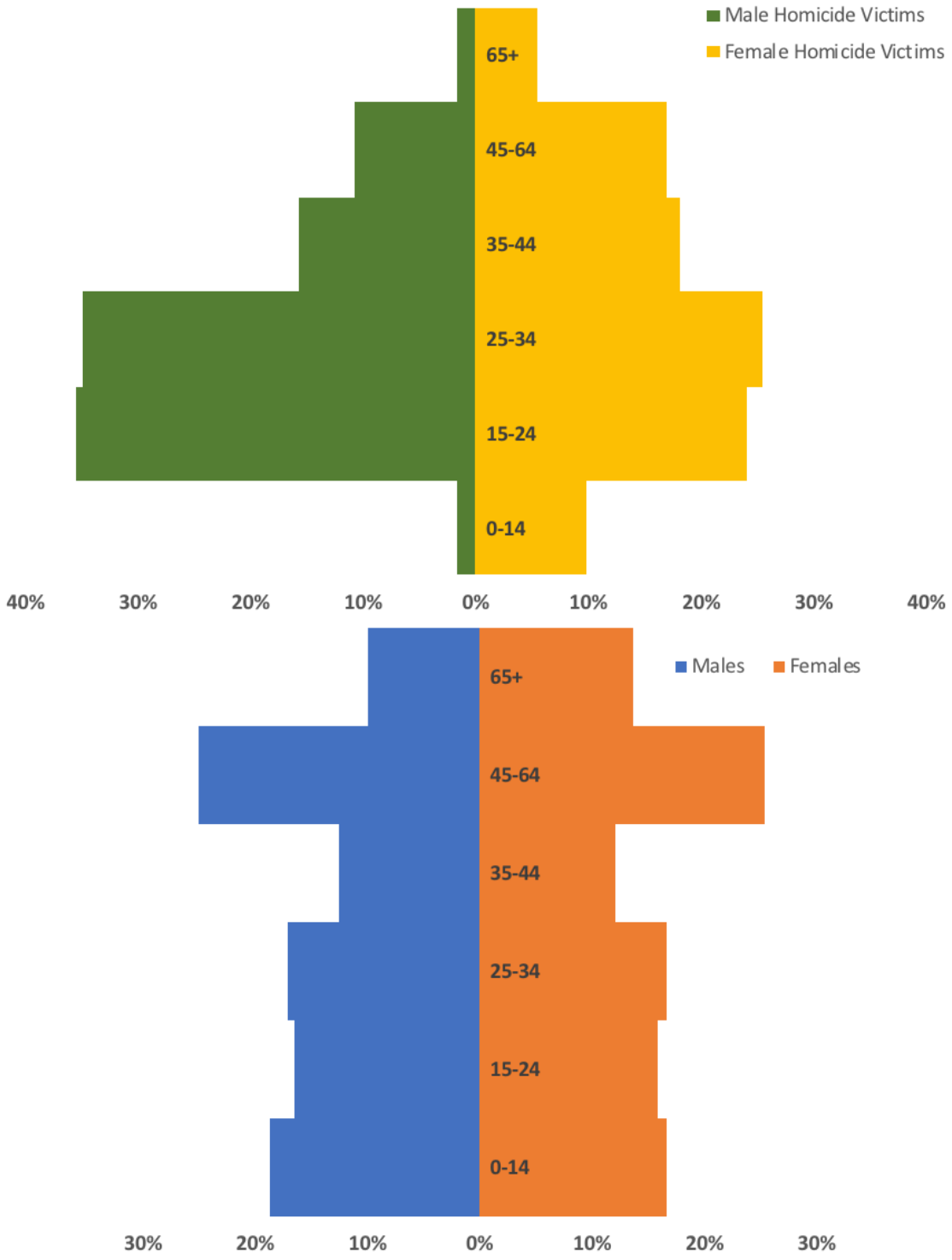


Figure 3.5 – Population pyramid for homicide victims reported to the news-based database between 2005 and 2017, compared to the population pyramid of Baltimore City based on the 2016 US Census estimate.

Figure 3.6

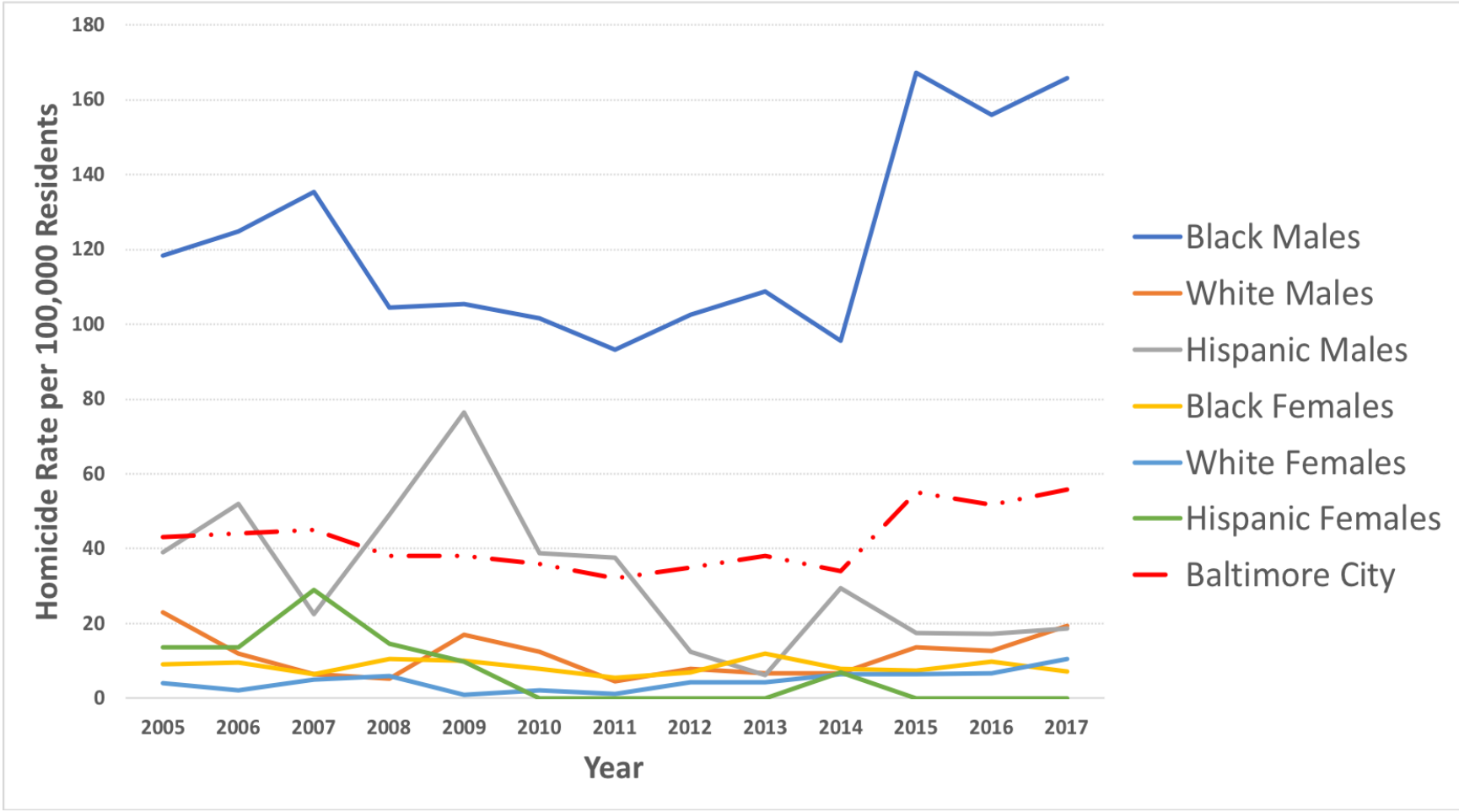


Figure 3.6 – Homicide rate per 100,000 residents by race/ethnicity and gender by year reported to the news-based database between 2005 and 2017.

Figure 3.7

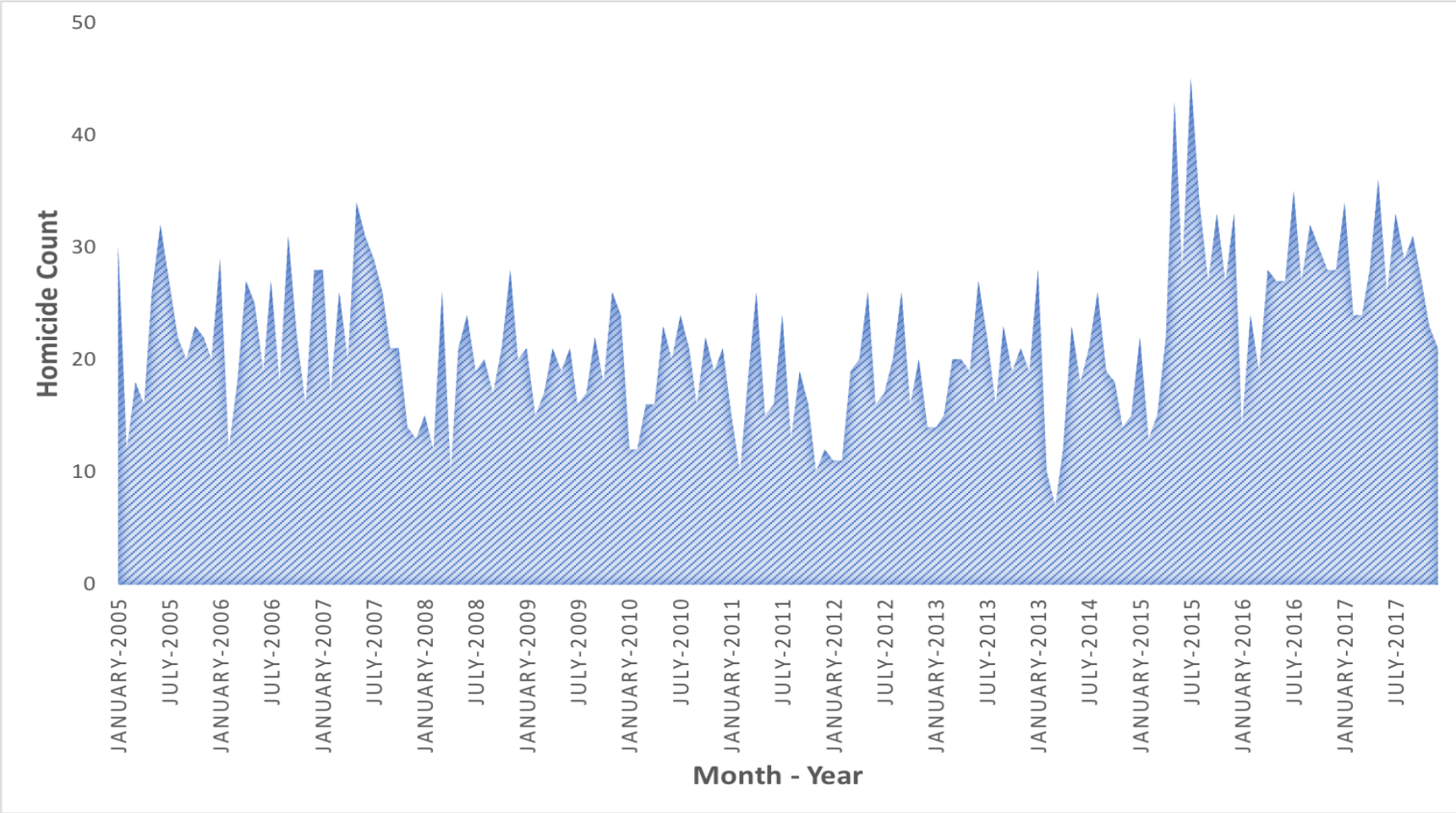


Figure 3.7 – Number of homicides by month in Baltimore City reported to the news-based database between January 2005 and December 2017. Note the seasonality of the homicide frequencies, with colder months (e.g. January) showing lower counts and warmer months (e.g. July) showing higher counts.

Figure 3.8

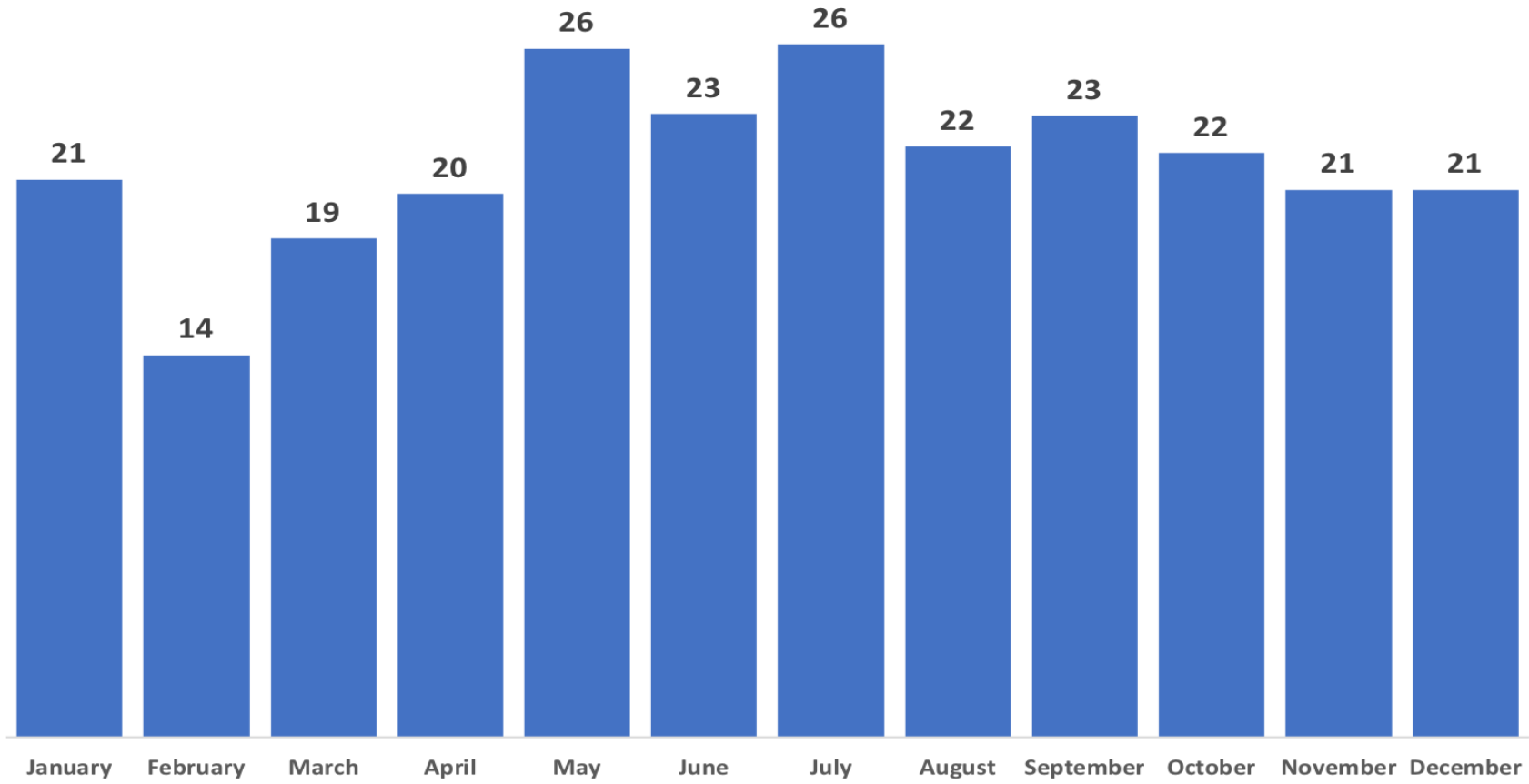


Figure 3.8 – Average yearly homicide count by month reported to the news-based database between January 2005 and December 2017. Note the lower average count in the colder months of January to March and the increase in the average count during the warmer months starting in May.

Figure 4.1

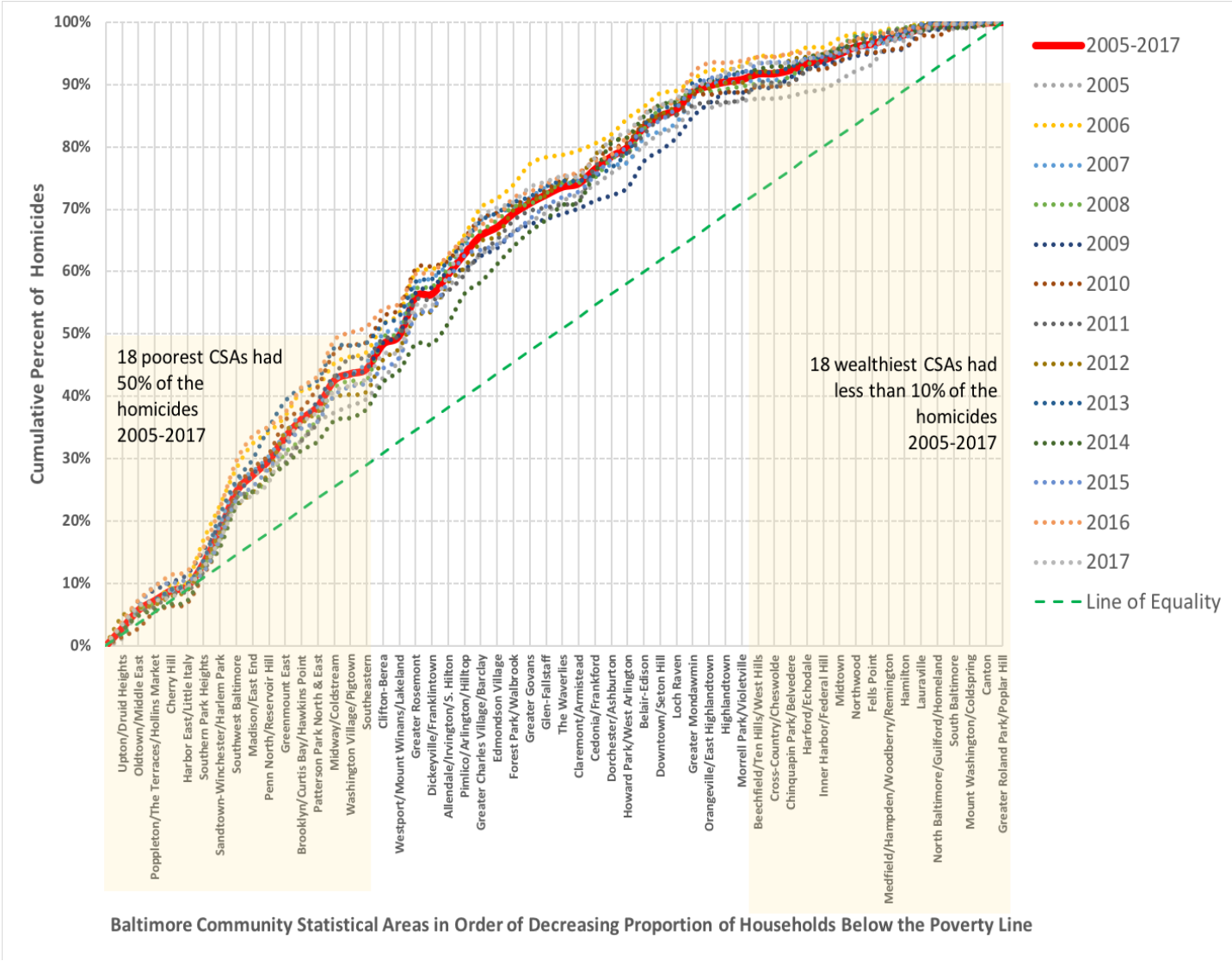


Figure 4.1 – Concentration Curve of homicides by Community Statistical Areas (CSAs) in Baltimore City. CSAs are ordered in decreasing proportion of households below the poverty line (poorest to wealthiest). Note the year-after-year inequality in the distribution of homicides.

Figure 4.2

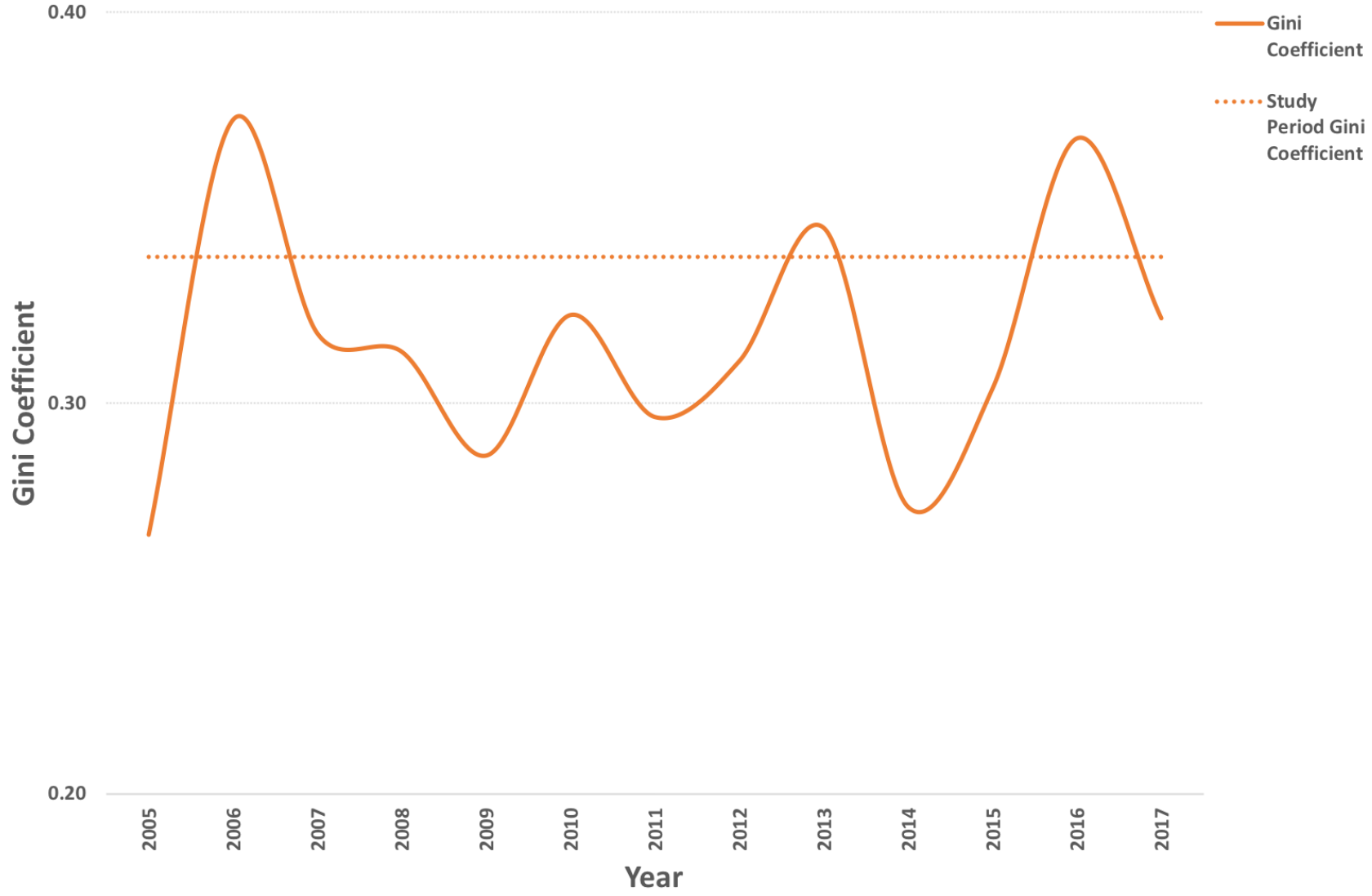


Figure 4.2 – Differences in Gini Coefficient across time when measuring the concentration of homicides by Community Statistical Area (CSA) level of poverty. While some years had more inequality than others, the coefficient was within a range of 0.27 and 0.37 throughout the study period of 2005 to 2017.

Figure 4.3

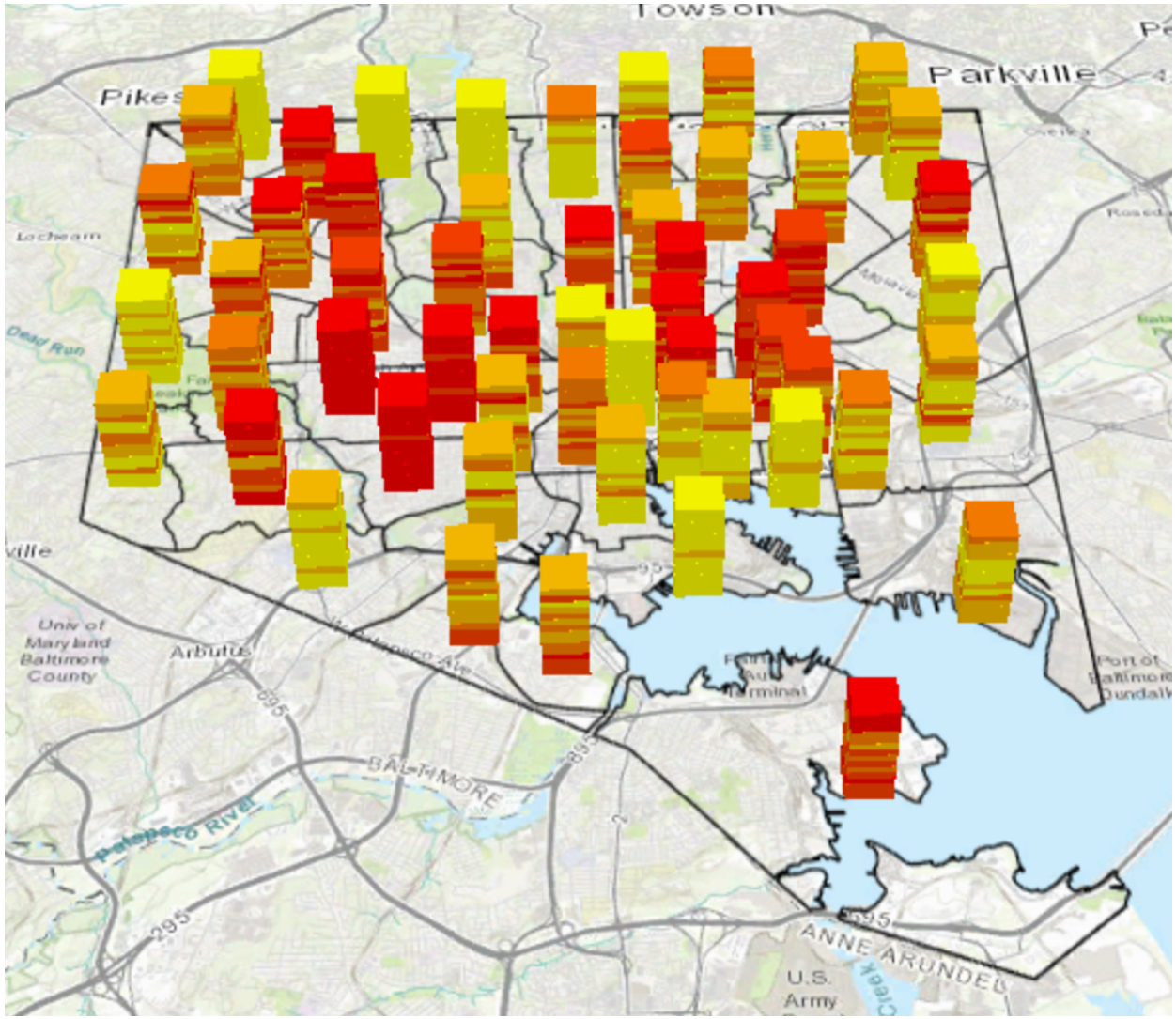


Figure 4.3 – Visualization of Time Cube analysis of homicide counts by Community Statistical Area in Baltimore between 2005 and 2017.

Figure 4.4

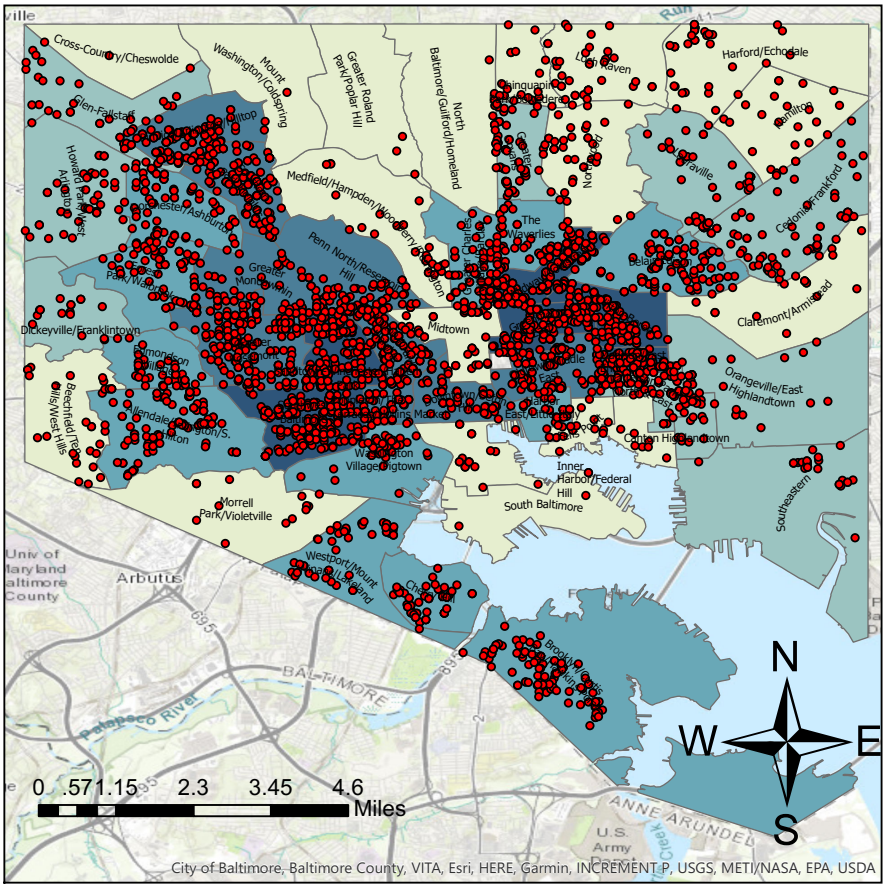
Time Step (Year)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Description
New													X	A location that is a statistically significant hot spot for the final time step and has never been a statistically significant hot spot before.
Consecutive									X	X	X	X	X	A location with a single uninterrupted run of statistically significant hot spot bins in the final time-step intervals. The location has never been a statistically significant hot spot prior to the final hot spot run and less than ninety percent of all bins are statistically significant hot spots.
Intensifying		X+	X+	X+	X+	X+	X+	X+	X+	X+	X+	X+	X+	A location that has been a statistically significant hot spot for ninety percent of the time-step intervals, including the final time step. In addition, the intensity of clustering of high counts in each time step is increasing overall and that increase is statistically significant.
Persistent	X	X	X	X	X	X		X	X	X	X	X	X	A location that has been a statistically significant hot spot for ninety percent of the time-step intervals with no discernible trend indicating an increase or decrease in the intensity of clustering over time.
Diminishing		X-	X-	X-	X-	X-	X-	X-	X-	X-	X-	X-	X-	A location that has been a statistically significant hot spot for ninety percent of the time-step intervals, including the final time step. In addition, the intensity of clustering in each time step is decreasing overall and that decrease is statistically significant.
Sporadic		X		X		X		X	X		X			A location that is an on-again then off-again hot spot. Less than ninety percent of the time-step intervals have been statistically significant hot spots and none of the time-step intervals have been statistically significant cold spots.
Oscillating		X		C		X		X			X		X	A statistically significant hot spot for the final time-step interval that has a history of also being a statistically significant cold spot during a prior time step. Less than ninety percent of the time-step intervals have been statistically significant hot spots.
Historical	X	X	X	X	X	X	X	X	X	X	X	X		The most recent time period is not hot, but at least ninety percent of the time-step intervals have been statistically significant hot spots.

X = Statistically Significant Hot Spot or Cold Spot
C = Statistically Significant Cold Spot
+ = Increasing Intensity
- = Decreasing Intensity

Figure 4.4. Description of emerging hot spots and cold spots.

Maps

Map 4.1: Homicide Rates Per 100,000 Residents by Community Statistical Area in Baltimore, 2005 to 2017



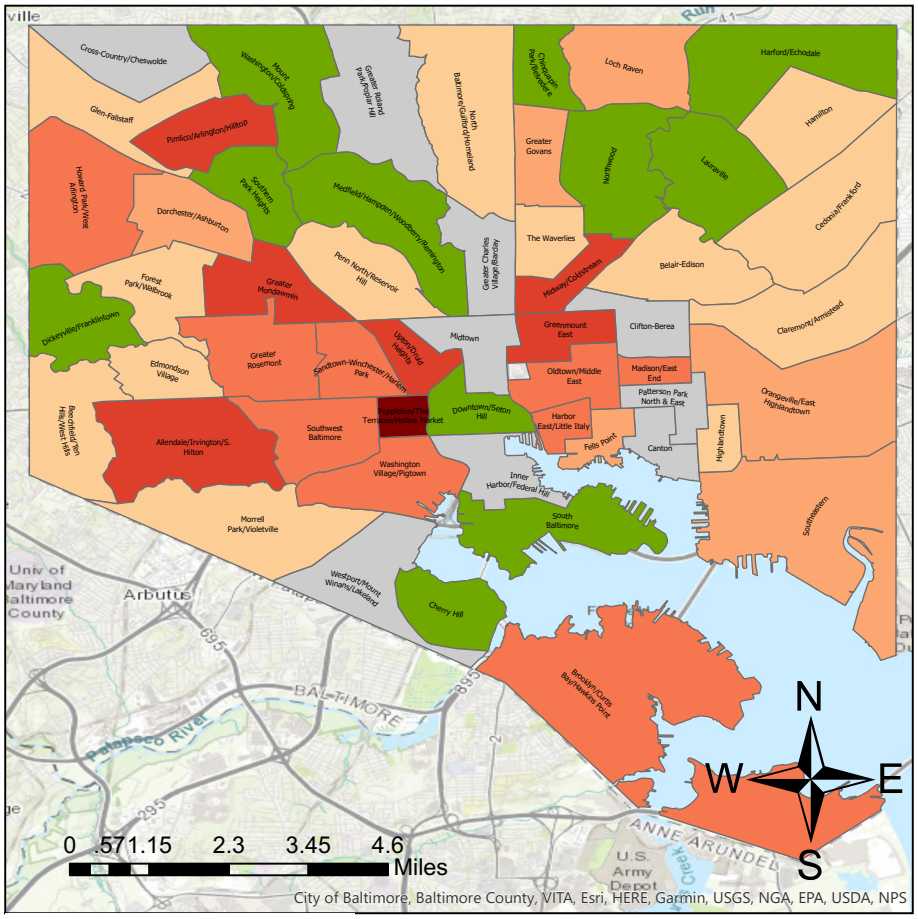
Legend

- 2005-2017 Homicides

Homicide Rate per 100,000 Residents

- ≤20
- 20 - 40
- 41 - 60
- 61 - 80
- 81 - 101

Map 4.2: Change in Yearly Average Homicide Rates Per 100,000 Residents Between the Pre-Epidemic (2005-2014) and Epidemic (2015-2017) Time Periods



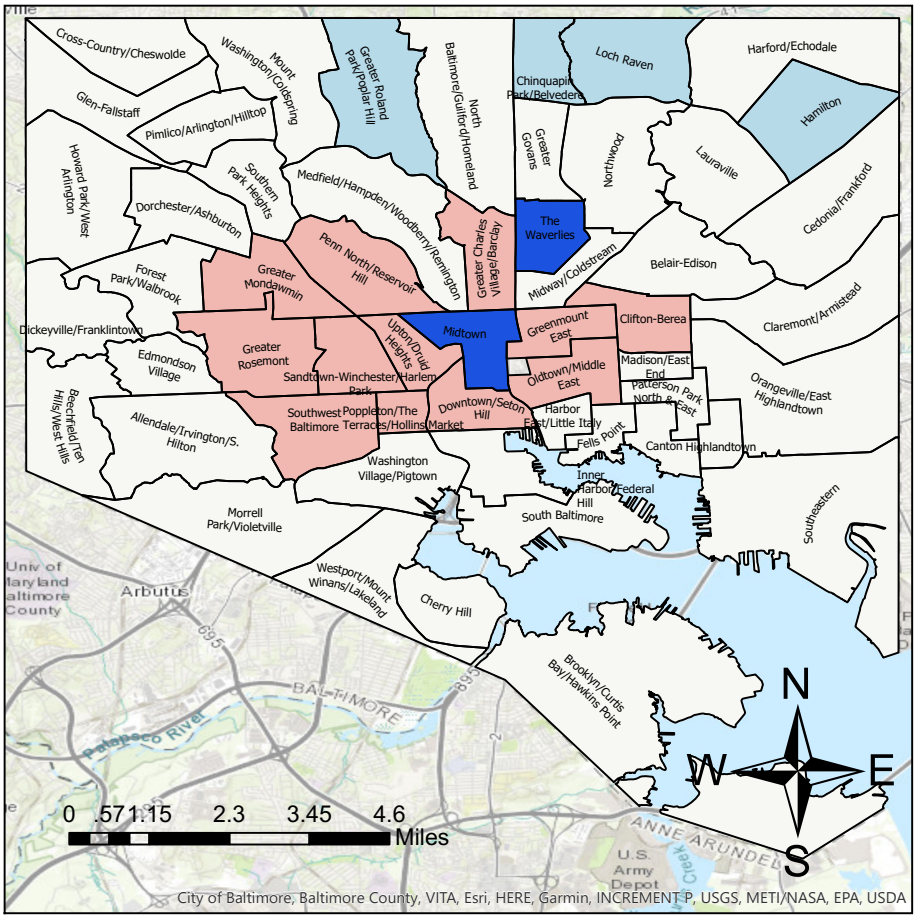
Legend

Pre-Epidemic vs Epidemic Time Periods

Difference in Epidemic Rates

- -17.5 to -1.9
- -2 to 2
- 2.1 to 14
- 14.1 to 26
- 26.1 to 37
- 37.1 to 53.7
- 85.4

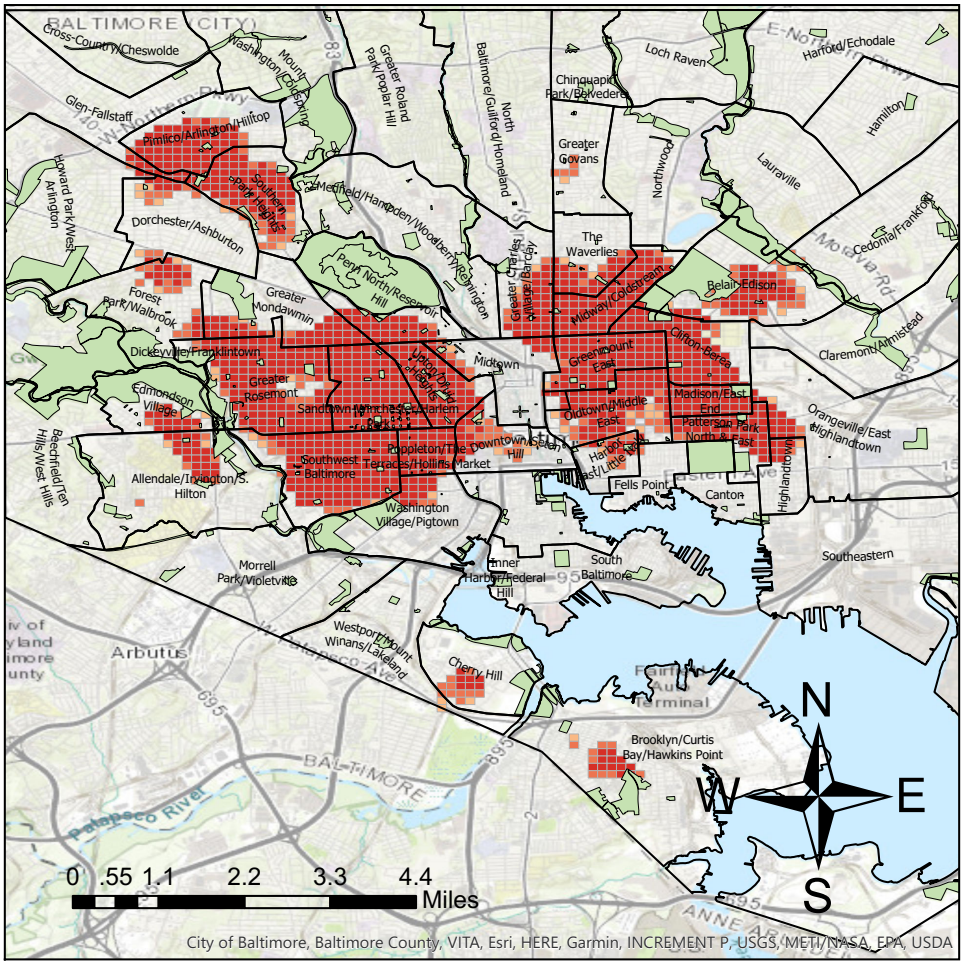
Map 4.3: Spatial Clustering of Homicide Rates Per 100,000 Residents by Community Statistical Area Using Moran's I



Legend

- Community Statistical Area
- High-High Cluster
- High-Low Outlier
- Low-High Outlier
- Low-Low Cluster
- Not Significant

Map 4.4: Optimized Hot Spot Analysis of 2005 to 2017 Homicides in Baltimore.



Community Statistical Area Boundaries

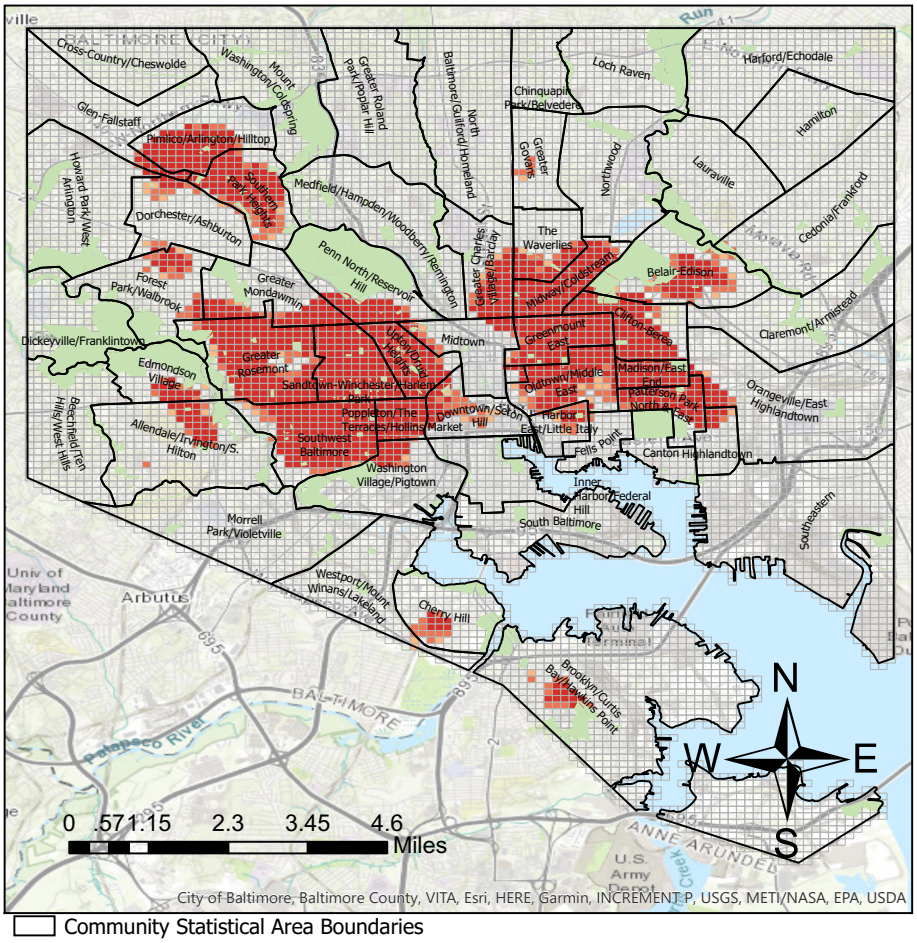
Parks

2005-2017 Optimized Hot Spot Analysis

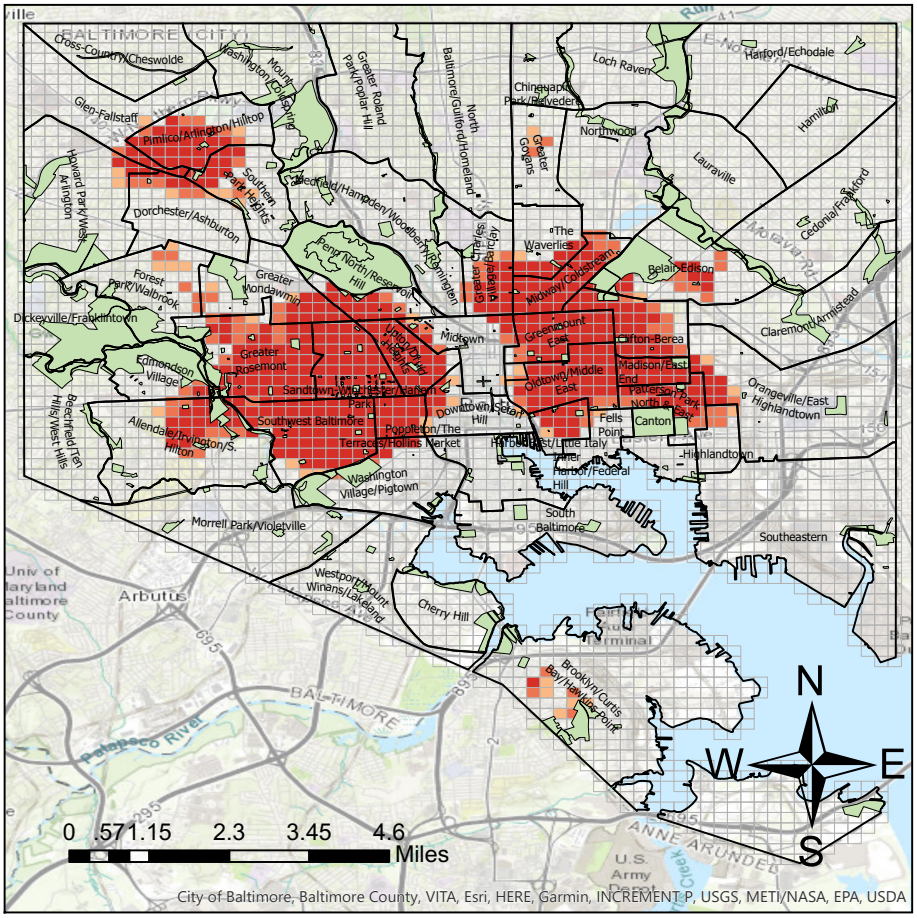
Hot Spot - Cold Spot Results

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Map 4.5: Optimized Hot Spot Analysis of 2005 to 2014 Homicides in Baltimore



Map 4.6: Optimized Hot Spot Analysis of 2015 to 2017 Homicides in Baltimore



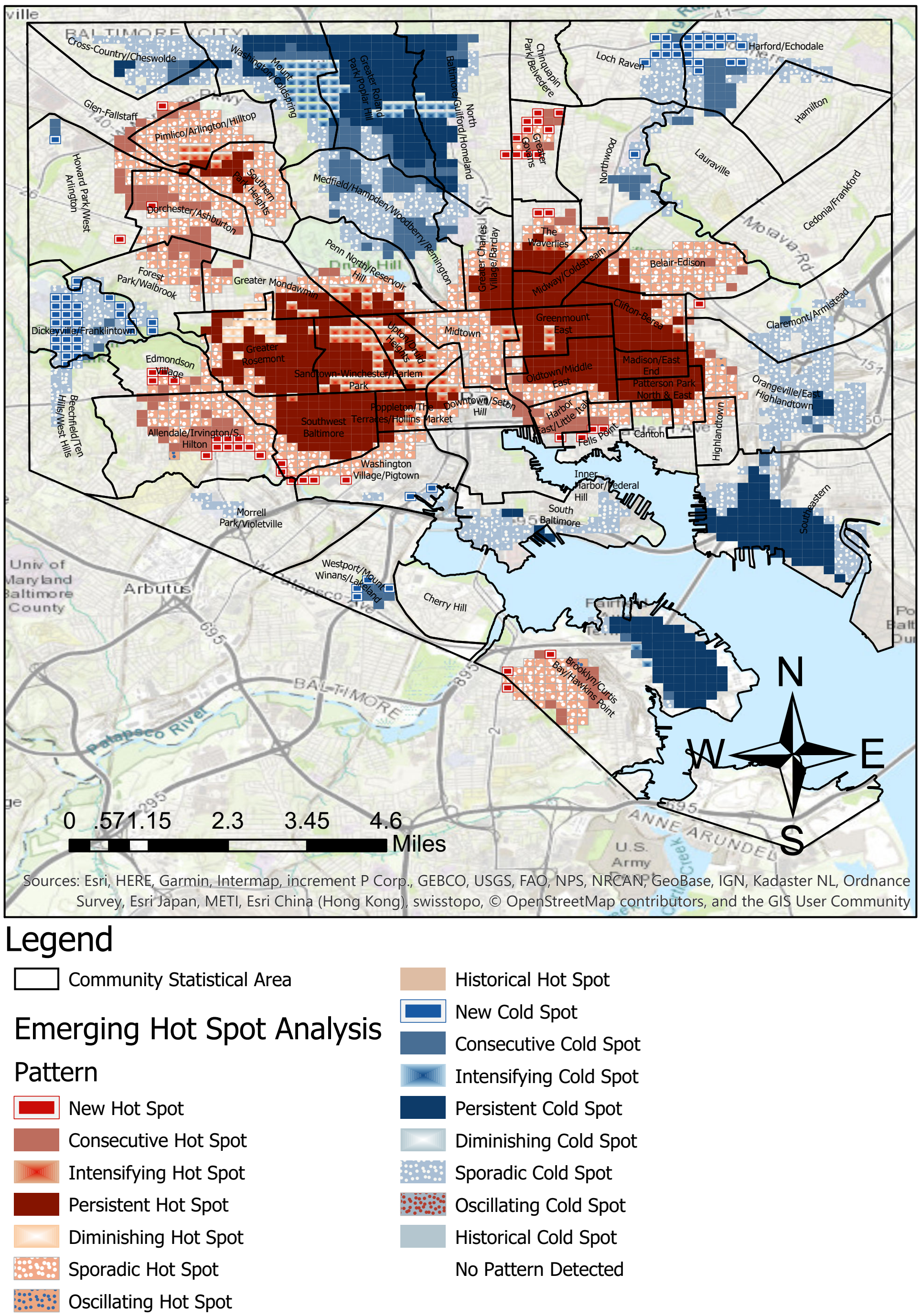
Legend

- Community Statistical Area Boundaries
- Parks

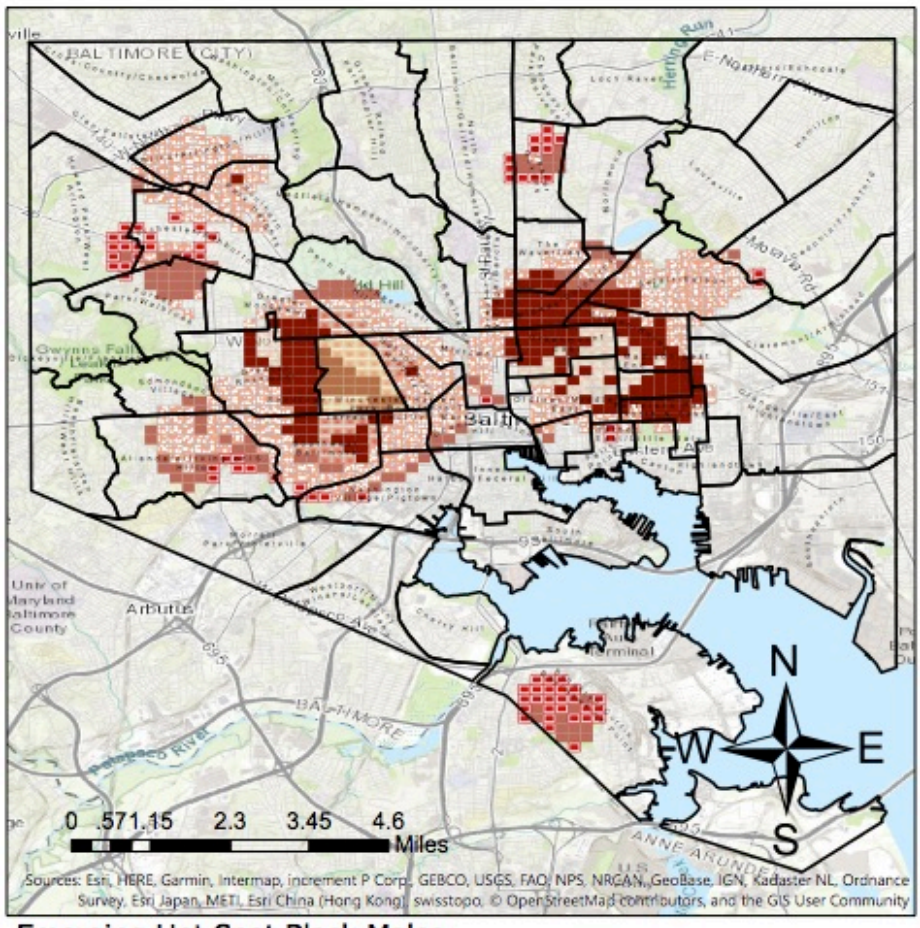
2015-2017 Optimized Hot Spot Analysis

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

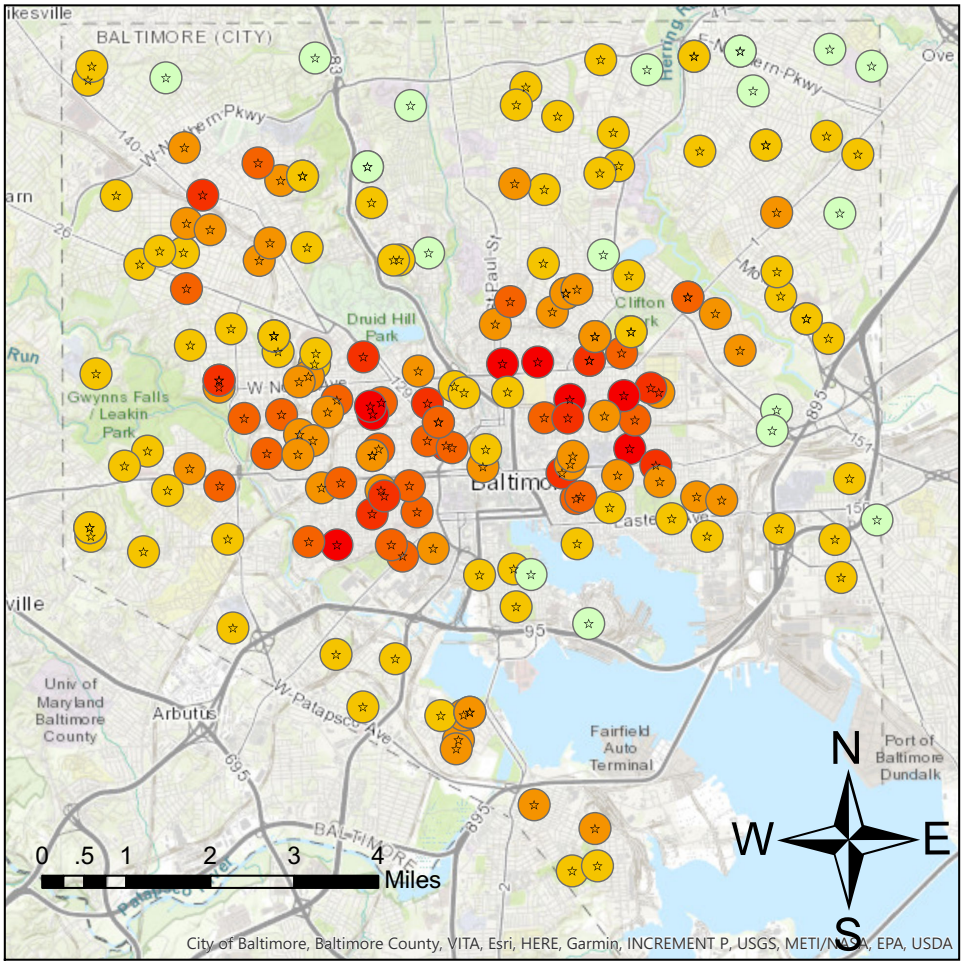
Map 4.7: Map Showing the Results of an Emerging Hot Spot Analysis of All Homicides Between 2005 and 2017



Map 4.8: Map of Emerging Hot Spots of Homicides Between 2005 and 2017 Where the Victims Were Male, Between the Ages of 15 and 35, and Killed by Firearm



Map 4.9: Spatial Distribution and Number of Homicides Within 1,000 Feet of Public Schools in Baltimore City Between 2005 and 2017



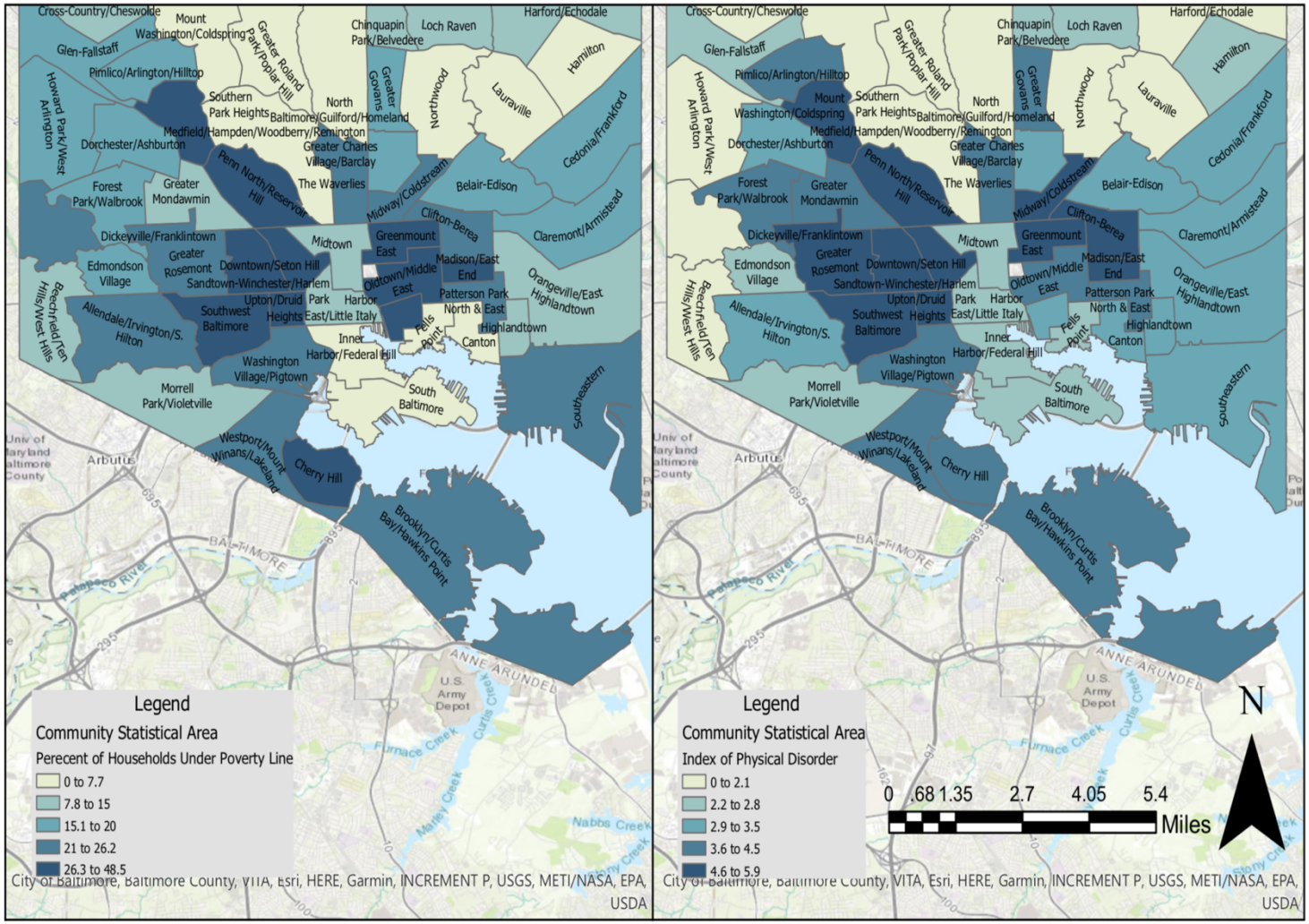
Legend

- ☆ Baltimore City Public School

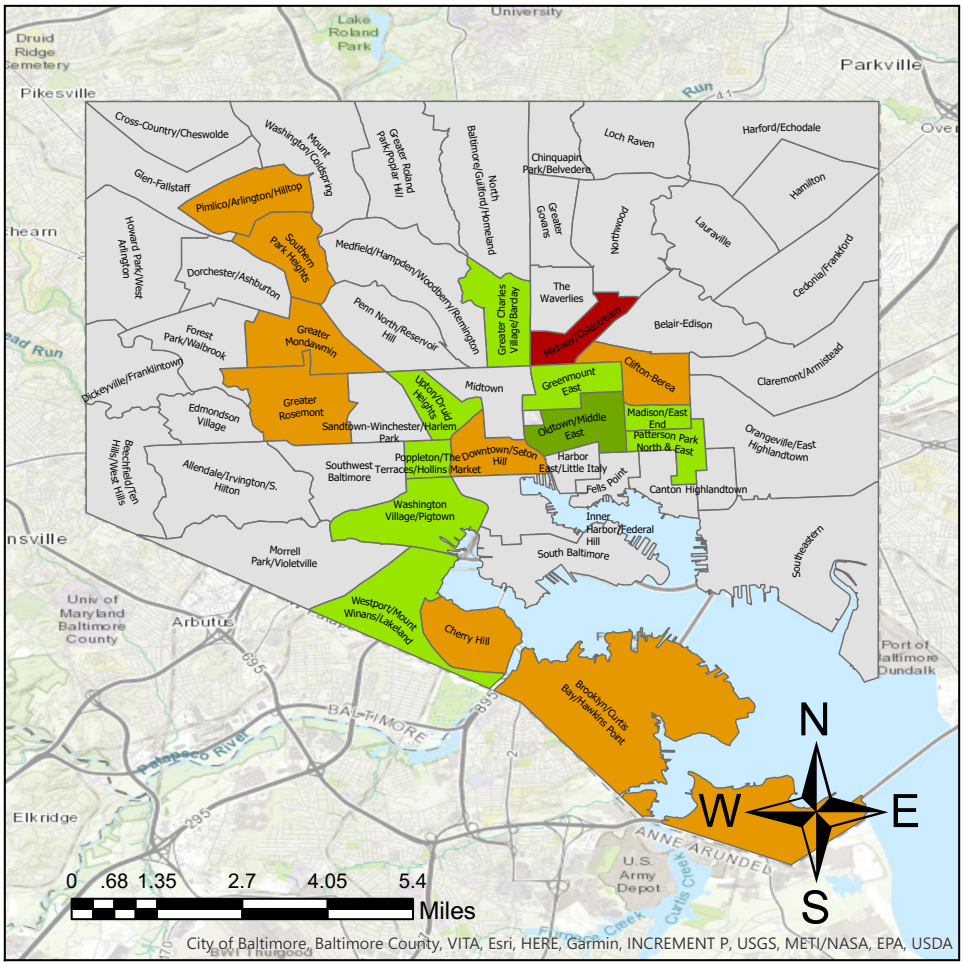
Homicides 2005 to 2017 within 1,000ft of School

- No Homicides
- 1 to 6 Homicides
- 7 to 13 Homicides
- 14 to 19 Homicides
- 20 to 25 Homicides
- 26 to 33 Homicides

Map 4.10: Comparison of Location and Concentration of Households Living Under the Poverty Level with Neighborhood Physical Disorder Index



MAP 4.11: Change in Average Yearly Proportion on Vacant Housing Between Non-Epidemic (2005-2014) and Epidemic (2015-2017) Time Periods

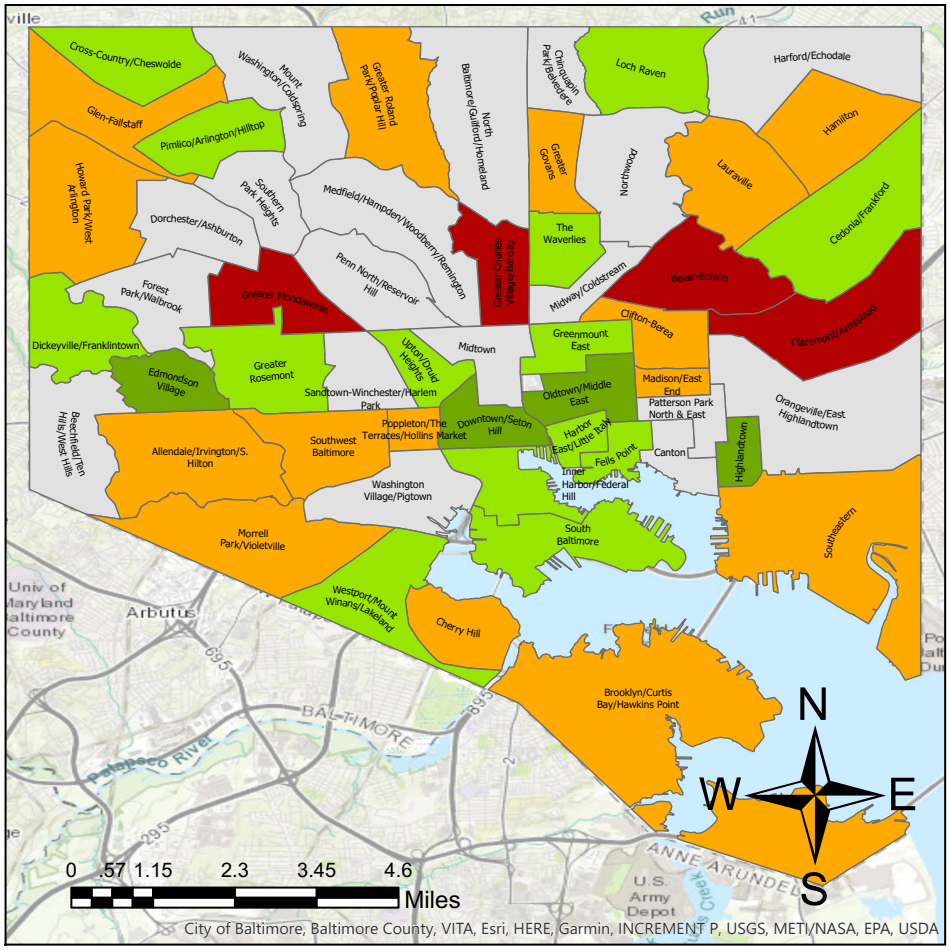


Legend

Change in Percent of Vacant Housing

- -13.4% to -6%
- -5.9% to -1%
- -0.9% to 1%
- 1.1% to 5.9%
- 6%

MAP 4.12: Change in Yearly Percent of Households Living Under the Poverty Line Between the



Legend

Change in Percent of Households Living Under Poverty Line

- -11% to -5%
- -4.9% to -1%
- -0.9% to 1%
- 1.1% to 4%
- 4.1% to 6%

Appendix A

Definitions

- Neighborhood Indicators for Environmental Typology (NIfETy) (Smart, 2008)
    - Physical Disorder: “Number of broken windows; abandoned houses; vacant lots; presence of trash; evidence of vandalism; number of potholes; number of abandoned vehicles; evidence of landscaping.” These observations were aggregated into an index ranging from 0 to 9, with 0 representing the least amount of disorder and 9 the most amount of disorder.
    - Youth Activity: “Number of children on the street; youth riding bicycles; youth doing drugs.” Like with Physical Disorder, these observations were also aggregated into an index.
    - Violence, Alcohol and Other Drugs: “Shell casings, police tape/outlines, memorials on the block; number of people smoking tobacco, consuming alcohol, using or selling drugs.” Like with Physical Disorder and Youth Activity, these observations were also aggregated into an index.
- Emerging Hot Spot Analysis (ESRI, 2016)
    - Consecutive Hot Spot or Cold Spot: “A location with a single uninterrupted run of statistically significant hot/cold spot bins in the final time-step intervals. The location has never been a statistically significant hot/cold spot prior to the final hot spot run and less than ninety percent of all bins are statistically significant hot/cold spots.”

- Diminishing Hot Spot or Cold Spot: “A location that has been a statistically significant hot/cold spot for ninety percent of the time-step intervals, including the final time step. In addition, the intensity of clustering in each time step is decreasing overall and that decrease is statistically significant.”
- Historical Hot Spot or Cold Spot: “The most recent time period is not hot/cold, but at least ninety percent of the time-step intervals have been statistically significant hot/cold spots.”
- Intensifying Hot Spot or Cold Spot: “A location that has been a statistically significant hot/cold spot for ninety percent of the time-step intervals, including the final time step. In addition, the intensity of clustering of high/low counts in each time step is increasing overall and that increase is statistically significant.”
- New Hot Spot or Cold Spot: “A location that is a statistically significant hot/cold spot for the final time step and has never been a statistically significant hot/cold spot before.”
- Oscillating Hot Spot or Cold Spot: “A statistically significant hot/cold spot for the final time-step interval that has a history of also being a statistically significant cold/hot spot during a prior time step. Less than ninety percent of the time-step intervals have been statistically significant hot/cold spots.”
- Persistent Hot Spot or Cold Spot: “A location that has been a statistically significant hot/cold spot for ninety percent of the time-step intervals with no discernible trend indicating an increase or decrease in the intensity of clustering over time.”

    - Sporadic Hot Spot or Cold Spot: “A location that is an on-again then off-again hot/cold spot. Less than ninety percent of the time-step intervals have been statistically significant hot/cold spots and none of the time-step intervals have been statistically significant cold/hot spots.”
- Cause of Death: The disease process or injury that leads to death. For example, a gunshot wound to the leg is the cause of death, while exsanguination is the mechanism of death and homicide would be the manner of death.
- Census Tract: “A small, relatively permanent statistical subdivisions of a county or equivalent entity that are updated by local participants prior to each decennial census as part of the Census Bureau's Participant Statistical Areas Program. The Census Bureau delineates census tracts in situations where no local participant existed or where state, local, or tribal governments declined to participate. The primary purpose of census tracts is to provide a stable set of geographic units for the presentation of statistical data. Census tracts generally have a population size between 1,200 and 8,000 people, with an optimum size of 4,000 people. A census tract usually covers a contiguous area; however, the spatial size of census tracts varies widely depending on the density of settlement. Census tract boundaries are delineated with the intention of being maintained over a long time so that statistical comparisons can be made from census to census. Census tracts occasionally are split due to population growth or merged as a result of substantial population decline.” (US Census Bureau, 2012)
- Community Statistical Area: A geographical unit created by the Baltimore City Department of Planning which clusters the over 270 neighborhoods in Baltimore in order to give “a consistent representation of the conditions occurring within particular

neighborhoods." Community Statistical Areas have boundaries that align with census tracts, have a population between 5,000 and 20,000 residents, are relatively homogeneous with respect to demographics, and reflects the common understanding of a community's boundaries (Baltimore Neighborhood Indicators Alliance, 2018a).

- Manner of Death: The circumstance(s) that led to death. The manner of death can include homicide, suicide, accidental, natural, or undetermined. For example, a gunshot wound to the leg is the cause of death, while exsanguination is the mechanism of death and homicide would be the manner of death.
- Mechanism of Death: The physiologic process that leads to death. For example, a gunshot wound to the leg is the cause of death, while exsanguination is the mechanism of death and homicide would be the manner of death.
- Neighborhood Statistical Area: Similar to a Community Statistical Area, a Neighborhood Statistical Area delineates a neighborhood and maintains that area constant over time for comparisons. These neighborhoods may overlap other geographic units, such as ZIP codes.
- Primary Prevention: Prevention measures aimed at preventing the initial onset of a disease or condition, and at reducing the incidence of said disease or condition.
- Secondary Prevention: Prevention measures aimed at early identification and treatment of a disease or condition, and at reducing the progression of the disease or condition beyond its initial stages.
- Tertiary Prevention: Prevention measures aimed at maintaining the best possible health once a disease or condition has set in.

- Violent Death: “A death resulting from the intentional use of physical force or power against oneself, another person, or against a group or community. The person using the force or power need only have intended to use force or power; they need not have intended to produce the consequence that actually occurred. “Physical force” should be interpreted broadly to include the use of poisons or drugs. The word “power” includes acts of neglect or omission by one person who has control over another.” (Krug et al., 2002)

Appendix B

Variables and Their Analysis for Chapter 3

Age

The ages for all homicide victims in both databases were available. Because of the completeness of the cases for 2016 and 2017, we used the ages in the news-based database for analysis. We calculated age means and confidence intervals for different categories of victims, starting with gender categories and then race categories. We conducted independent group t-tests in order to identify any statistical difference in the mean ages of the different categories. We calculated the Years of Potential Life Lost (YPLL) by taking the average of the life expectancy in Baltimore between 2011 and 2016 and subtracting the ages of the victims. We then added the products of those subtractions to obtain a total YPLL value.

Gender

Data from the news-based database were used to determine the proportion of violent deaths by gender as well as rates for the overall study period and for each year within the study period. To calculate the age-adjusted rates, we used data from the 2010 United States Census. In this study, we used gender as reported in the news-based database which, in turn, uses information gathered from media briefings by law enforcement or by interviews of acquaintances of the victims.

Race/Ethnicity

We used the data in the news-based database for the analysis of race. We classified the race of the victims into four categories: African American, white, Asian and other. In the *other*

category, we included Native American victims, and Pacific Islander victims, if any. We then used the designation of Hispanic for those victims identified as such in the news-based database. While there may be some Hispanic black victims or Hispanic white victims, these subsets of the Hispanic ethnicity were not specified in the news reports.

Educational Attainment

The education level was classified into two categories: *No High School* if the victim had not finished high school nor obtained a GED, and *At Least High School* if the victim had at least a high school diploma or GED. Children in this analysis were categorized as *No High School* due to their age. In Maryland, all children aged 16 and younger are required by law to attend school, as a result, all children were categorized as *No High School* even if their education was unknown or missing (Md. Code. Education §7-301).

Employment Status

Employment was entered into the *Maryland Violent Death Reporting System* through a free-text field derived from the death certificate information. As a result, the list of occupations was long and varied. Nevertheless, of the 2,683 cases in the database, 142 (5%) were entered as "unknown" and 10 (<1%) were missing an entry. The variables were coded into a binary variable for *employed* and *unemployed*. We then conducted a logistic regression with that variable as the dependent variable, and gender and race as the independent variables to obtain an odds ratio of the odds of employment between males and females, and between African American and non-African American victims, white and non-white victims, and Hispanic and non-Hispanic victims.

Marital Status

Marital status is usually reported in the death certificate or reported by law enforcement and/or the medical examiner. For this analysis, we classified adult homicide victims only into three categories: *Married/Civil Union, Never Married,* and *Other/Not Married*. If the homicide victim has been reported as divorced, a widow(er) or any other status in which they were previously married, they were classified as *Other/Not Married.* For this analysis, same-sex marriages and civil unions were classified as *Married/Civil Union*.

Presence of Alcohol and Other Drugs and Substances

The Office of the Medical Examiner may have performed toxicology tests on homicide victims. The results of these tests are entered into the *Maryland Violent Death Reporting System* if they are available. Tests for alcohol were not routinely submitted until 2012. Before that time, alcohol testing results were reported in the database if they were part of the overall victim record. Starting in 2012, the database includes results for alcohol testing. Other substances were also reported, though they are not all illegal drugs or drugs of abuse. Appendix C has a list of the substances found in the homicide victims reported in the *Maryland Violent Death Reporting System* between 2005 and 2015. (Appendix C)

Injured at Home

Information on the type of location where the homicide occurred is received from law enforcement and/or the medical examiner. We coded this variable as *At Home/Not At Home* based on the location description and the report of where the homicide occurred. If the homicide occurred at the victim's usual place of residence, then it was categorized as a homicide occurring at home.

Intimate Partner Violence

A homicide is classified as being intimate partner violence if the homicide results from violence between current or former intimate partners. An intimate partner is defined as "a current or former girlfriend/boyfriend, dating partner, ongoing sexual partner, or spouse." Sexual intimacy is not required for this relationship to be classified as intimate, and it includes same-sex relationships.

Homelessness

A homicide victim is reported as homeless if they reside in a place not designed as a human dwelling (e.g. a car or an outdoor area), in a public or private shelter for people who do not have a permanent place to reside, or in a transitional home setting for the homeless. Furthermore, these victims were reported as homeless only if there was clear evidence that they met the definition of homelessness. Homelessness was coded as *Unknown* if their home address was not known/not reported and their homeless status could not be ascertained.

Gang Involvement

A homicide that occurs as the result of gang activity, or where either the perpetrator or victim are gang members, is classified as having gang involvement. This information is received from law enforcement and/or from the medical examiner ("National Violent Death Reporting System (NVDRS) Coding Manual Revised," 2015).

Cause of Death

Information on the type of weapon used in the commission of the homicide was obtained via law enforcement and/or the medical examiner. Based on the primary mechanism of injury and cause of death, homicides were categorized into three categories: *Firearm, Stabbing,* and *Other.* If the primary weapon used was a firearm of any kind, then it was coded as a *Firearm-*

related homicide. If the primary weapon was a cutting instrument of any kind, or the homicide was reported as a stabbing, then the homicide was coded as a *Stabbing*. If the homicide was the result of any other cause/mechanism (e.g. strangulation, asphyxiation, arson, etc.), then the homicide was coded as *Other*.

High School Completion Rate

The *Baltimore Neighborhood Indicators Alliance* defines high school completion rate as: "The percentage of 12th graders in a school year that successfully completed high school out of all 12th graders within an area. Completers are identified as completing their program of study at the high school level and satisfying the graduation requirements for a Maryland High School Diploma or the requirements for a Maryland Certificate of Program Completion."(Baltimore Neighborhood Indicators Alliance — Jacob France Institute, 2018) We averaged this rate over the years it was available (2009–2016) and used it in a negative binomial regression to predict the average (expected) number of homicides in a Community Statistical Area.

Appendix C

List of Substances Found in Homicide Victims From 2012 to 2015

Substance Name	*Description*	*Substance Name*	*Description*
6-monoacetylmorphine	Metabolite of heroin, a drug of abuse.	**Hydromorphone**	Prescription drug; Opiate analog; Pain Control
7-aminoclonazepam	Prescription Drug; Sedative	**Hydroxyzine**	Prescription Drug; Antihistamine
Acetaminophen	Over-the-Counter Drug; For pain and cold/flu symptoms	**Ketamine**	Prescription Drug; Anesthetic
Acetone	Product of fat metabolism	**Levetiracetam**	Prescription drug; anticonvulsant; Sedative; Mood Stabilizer
Alcohol	Drug of abuse	**Lidocaine**	Prescription Drug; Anesthetic
Alprazolam	Prescription Drug; Sedative	**Mda**	Illicit drug; Drug of Abuse; Recreational Drug
Amantadine	Prescription Drug; Antiviral	**Mdma**	Illicit drug; Drug of Abuse; Recreational Drug
Amitriptyline	Prescription Drug; Antidepressant	**Mdpv / Mdpk**	Stimulant; Drug of Abuse; Recreational Drug; Illicit Drug
Amphetamine	Prescription Drug; May be used illicitly	**Meprobamate**	Prescription Drug; Anxiety
Antidepressant	Prescription Drug; Antidepressant	**Methadone**	Prescription Drug; Opiate Analog; Pain Control
Atropine	Prescription Drug; Involuntary nervous system blocker	**Methadone Metabolite**	Metabolite of methadone, a prescription drug medication for pain
Bath Salts	Drug of abuse; Recreational Drug	**Methamphetamine**	Drug of Abuse; Recreational Drug; Prescription Drug; Stimulant
Benzodiazepines	Prescription Drug; Sedative	**Methylone 40**	Drug of abuse; Recreational Drug; Illicit Drug
Benzoylecgonine	Metabolite of cocaine, a drug of abuse	**Methylphenidate**	Prescription Drug; Stimulant
Brompheniramine	Over-the-Counter; Antihistamine	**Metoclopramide**	Prescription Drug; Intestinal Stimulant
Bupivacaine	Prescription Drug; Anesthetic	**Metoprolol**	Prescription Drug; Blood Pressure
Bupropion	Prescription Drug; Antidepressant	**Midazolam**	Prescription Drug; Anesthetic
Carbamazepine	Prescription drug; anticonvulsant, sedative	**Mirtazapine**	Prescription Drug; Antidepressant
Carbon Monoxide	Environmental Pollutant	**Morphine**	Prescription Drug; Drug of Abuse; Pain Control
Chlordiazepoxide	Prescription Drug; Sedative	**Nordiazepam**	Metabolite of Diazepam, a prescription drug
Chlorpheniramine	Over-the-Counter; Antihistamine	**Norfluoxetine**	Metabolite of Fluoxetine, a prescription antidepressant

Substance Name	*Description*	*Substance Name*	*Description*
Citalopram	Prescription Drug; Antidepressant	**Nortriptyline**	Prescription drug; Antidepressant
Clonazepam	Prescription Drug; Sedative	**Olanzapine**	Prescription drug; Antipsychotic
Cocaine	Drug of abuse; Recreational Drug	**Opiates**	Prescription drug; Drug of abuse; Pain control
Cocaine Metabolite	Drug of abuse; Recreational Drug	**Oxycodone**	Prescription drug; Drug of abuse; pain control
Codeine	Prescription drug; Opiate analog; Pain Control	**Oxymorphone**	Metabolite of morphine, a prescription drug and drug of abuse.
Creatine	Natural component in human metabolism; Nutritional supplement	**Paroxetine**	Prescription drug; antidepressant
Cyclobenzaprine	Prescription Drug; Muscle relaxer	**Pentobarbital**	Prescription drug; anticonvulsant, sedative
Desmethylsertraline	Prescription Drug; Antidepressant	**Phencyclidine**	Illicit drug; Hallucinogen
Dextromethorphan	Over-the-counter drug; Cough Suppressant	**Pheniramine**	Antihistamine
Diazepam	Prescription Drug; Anxiety; Drug of abuse	**Phenobarbital**	Prescription drug; anticonvulsant
Diltiazem	Prescription Drug; Blood Pressure	**Phenylpropanolamine**	Over-the-counter drug; decongestant, appetite suppressant
Diphenhydramine	Over-the-Counter; Antihistamine	**Phenytoin**	Prescription drug; anticonvulsant
Diphenhydramine Hydrochloride	Over-the-Counter; Antihistamine	**Poison, Not Otherwise Specified**	N/A
Doxylamine	Over-the-counter; Sleep aid	**Potassium**	Prescription drug; Over-the-counter drug; Various uses
Ephedrine	Prescription; Antihistamine; Decongestant; Stimulant	**Procaine**	Prescription drug; Anesthetic
Ethanol	Alcohol. Drug of abuse.	**Promethazine**	Prescription Drug; Anesthetic
Etomidate	Prescription Drug; Anesthetic	**Propranolol**	Prescription drug; Blood pressure
Fentanyl	Prescription Drug; Opiate analog; Pain Control; Drug of Abuse	**Pseudoephedrine**	Over-the-counter drug; Medication for cold symptoms
Fluoxetine	Prescription Drug; Antidepressant	**Quetiapine**	Prescription drug; Antipsychotic
Free Morphine	Prescription Drug; Opiate analog; Pain Control; Drug of Abuse	**Quinine**	Prescription drug; Over-the-counter drug; Various uses

Glucose	Nutritive; Naturally Occurring	**Salicylates**	Prescription drug; Over-the-counter drug; Various uses; Aspirin

Substance Name	*Description*	*Substance Name*	*Description*
Haloperidol	Prescription drug; Antipsychotic	**Sertraline**	Prescription Drug; Antidepressant
Heroin	Illicit drug; Drug of Abuse; Recreational Drug	**Tramadol**	Prescription drug; Opiate analog; Pain Control
Hydrocodone	Prescription drug; Opiate analog; Pain Control	**Trazodone**	Prescription Drug; Antidepressant
		Zolpidem	Prescription drug; Sleep aid

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Curriculum Vitae

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PERSONAL DATA

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EDUCATION

- Johns Hopkins University Bloomberg School of Public Health, Baltimore, MD
    - 2013-2018 Doctor of Public Health
    - Brown Scholar in Community Health
    - Abraham Lilienfeld Scholarship recipient (2017)
- George Washington University, Washington, DC
    - 2003-07, Master of Public Health in Epidemiology and Biostatistics
- University of Texas at El Paso, El Paso, TX
    - 1995-2000, Baccalaureate of Science in Medical Technology

PROFESSIONAL EXPERIENCE

Consulting Epidemiologist, Centers for Disease Control and Prevention 2016

- Aided in the design and implementation of a survey of Puerto Rico physicians on their knowledge, practices and beliefs about Zika infection and treatment.
- Worked with Puerto Rican stakeholders on conducting a study to determine the baseline rate of abortions to evaluate the impact of Zika on abortion practices.
- Performed data validation and cleaning of a database composed of responses to a survey of expectant mothers in Puerto Rico done at the beginning of the Zika outbreak there.

Consulting Epidemiologist, Anne Arundel County Health Department 2015-2016

- Performed research for and writing of technical reports and public health emergency planning documents for the Division of Communicable Disease Management (CDM).
- Worked with CDM and emergency preparedness in planning a drive-through community influenza immunization clinic.
- Designed and implemented an online tool for disease investigation guidelines and documents for use in place of existing paper documents.

Teaching Assistant, JHU Bloomberg School of Public Health 2013-Present

- Coordinated and graded student assignment submissions, assisted in online instruction, and facilitated study groups and review sessions for students in the following courses:
    - Public Health Surveillance, Spring 2014-2017
    - Health Communications Programs, Spring 2014-2018
    - Professional Epidemiological Methods, Spring 2016-2018
    - Epidemiology and History of Human Viral Infections, Fall 2015
    - Infectious Disease Epidemiology, Fall 2015

Epidemiologist, Maryland Dept. of Health and Mental Hygiene, Baltimore, MD 2007-2013

- Conducted epidemiological surveillance of influenza, legionellosis, malaria, non-tuberculosis mycobacterial infections, and other diseases and conditions as needed.
- Coordinated the systematic collection, analysis, and dissemination of influenza data from over 50 different sites and contributors in Maryland.
- Assisted in the investigations of outbreaks of communicable disease.
- Presented surveillance findings at professional conferences and gatherings.
- Provided information to public health policymakers to aid in public health policy decisions.
- Attended professional meetings and conferences, exchanging ideas on improving disease surveillance and overall public health

Medical Technologist, Patient First, York, PA 2011-2015

- Collected and analyzed human samples for diagnostic testing in a clinical laboratory.
- Assisted nursing staff in triage of patients.
- Spanish-English interpreter for patients with limited English proficiency.

Medical Technologist, Keystone Migrant Health Clinic, Gettysburg, PA 2011-2014

- Collected and analyzed human samples from migrant workers for diagnostic testing and screening at reference laboratories during a seasonal clinic held each year from July to November.
- Spanish-English interpreter for patients with limited English proficiency.

Content Writer, History of Vaccines Project Blog 2012-2014

- Wrote blog entries at **http://historyofvaccines.org/blog** about vaccine/immunization news in order to inform the public on the risks and benefits of immunizations and to simplify complex scientific information for a lay audience.

Medical Technologist, Waynesboro Hospital, Waynesboro, PA 2000-2010

- Collected and analyzed human samples for diagnostic testing in a clinical laboratory.
- Oversaw the operations of the laboratory on overnight shifts, including directing laboratory assistants to maximize workflow.
- Assisted in the preparation and execution of the yearly health fair sponsored by Summit Health.

- Performed maintenance on analytical instruments as required by the instruments' manufacturers. Investigated and fixed instrument malfunctions as needed.
- Spanish-English interpreter for patients with limited English proficiency.

Adjunct Faculty, Hagerstown Community College, Hagerstown, MD 2003-2004

- Lectured on the theory of laboratory sciences to Associate Degree students in nursing, as well as students in laboratory technology and other allied health degrees.
- Instructed students on the techniques involved in phlebotomy, basic microbiology, urinalysis, and blood banking.

DrPH Practicum experience

- Lectured on epidemiological surveillance to graduate students at Universidad del Norte in Barranquilla, Colombia.
- Consulted on epidemiological surveillance methods with Barranquilla District Health Department and Atlántico Department (State) Health Department.
- Assisted in data collection during an outbreak investigation of Chikungunya disease in Mahates, Colombia.
- Assisted in active disease surveillance in Barranquilla, going door-to-door to survey for un- and under-immunized children, possible mosquito reservoirs, and febrile disease.

PUBLICATIONS

Najera, Rene F. and Reiss, Dorit Rubinstein. *First Do No Harm: Protecting Patients Through Immunizing Health Care Workers*. Health Matrix: Journal of Law-Medicine, Vol. 26, Issue 1, 2016. http://dx.doi.org/10.2139/ssrn.2562091

PRESENTATIONS

Najera, R., Rohn, D., Blythe, D. (June 2009). *A Web-Based Approach to Monitor Influenza-Like Illness Among Maryland Residents*. Poster presented at the annual meeting of the Council of State and Territorial Epidemiologists

Kathleen L. Dooling, K. Toews, L. Hicks, L. Garrison, R. Carpenter, G. Giambrone, E.M. Parker, S. Petit, J. Thompson, R. Najera, R. Mansmann, R. Lynfield, B. White, G. Langley, (April 2013). *Findings from the Year of Population-Based Active Surveillance*. Poster presented at the 62nd Annual Epidemic Intelligence Service Conference.

Najera, R. and Bridge Najera, D. (July 2013). *Understanding statistics in research studies.* American Mental Health counselors Association Annual Conference, Washington, D.C.

Najera, R and Bridge Najera, D. (December 2014) *Sense and nonsense about autism.* Pennsylvania School Counselor Association 59thAnnual Conference, Seven Springs, PA.

LETTERS TO THE EDITOR

- "H1N1 Vaccinations Are Necessary" Chambersburg Public Opinion; Chambersburg, PA. Available online at: http://www.publicopiniononline.com/ci_13520280

- "West Nile Virus in Adams County" Hanover Evening Sun; Hanover, PA. Available online at: http://www.eveningsun.com/story/opinion/2015/07/20/your-letters-west-nile-virus-adams-county/32456193/

KEY ACHIEVEMENTS

- Redesigned the influenza surveillance program at the Maryland Department of Health and Mental Hygiene to bring it in line with similar programs at other states. This included issuing a weekly report on influenza surveillance statistics, including data from clinical laboratories on rapid influenza testing.
- Developed and implemented a community-based influenza surveillance system ("MRITS", the Maryland Resident Influenza Tracking Survey). A first in the United States, this system of "participatory epidemiology" uses a weekly survey of Maryland residents to determine the geographic spread and severity of influenza-like illness in people who do not regularly come into contact with healthcare and/or established surveillance systems. (Details of this system are available at http://flusurvey.dhmh.md.gov.)
- Assisted in influenza surveillance and data reporting for policymakers during the 2009 H1N1 influenza pandemic. This included extending the surveillance systems beyond the traditional October - May time period and well into the summer of 2009. Coordinated the collection and delivery of human respiratory samples from local health departments for testing at the Maryland State Laboratories Administration.
- Assisted in the investigation of several large outbreaks of Legionnaires Disease (legionellosis) in different counties in Maryland. One involved tracking down and identifying over 20 cases in a rural community in western Maryland. Another involved the environmental assessment and water sample collection from water sources at a large, multi-purpose long-term care facility. Yet another investigation involved communication with the public about the disease since the outbreak was centered on a tourist destination.
- Participated in numerous interviews with local and national media with respect to influenza. These media sources included radio stations in the Washington, DC, and Baltimore region, as well as on National Public Radio, and USA Today.

PROFESSIONAL MEMBERSHIPS

- American Public Health Association 2013 – Present
- Council of State and Territorial Epidemiologists 2007 - Present
- American Society for Clinical Pathology 1999 - Present
- Health Occupations Students of America 1992-1995